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Comparative Analyses of Science Based Targets Scope 3 Emissions in Corporate Sustainability Policies

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Abstract

Companies worldwide are aligning with the goals of the Paris Agreement, which aims to limit global warming to below 2 °C, and preferably to 1.5 °C, above pre-industrial levels. Many companies are adopting the Science-Based Targets initiative (SBTi), a collaboration between organizations such as the United Nations Global Compact (UNGC), the World Wide Fund for Nature (WWF), the World Resources Institute (WRI), and the Carbon Disclosure Project (CDP). Through the implementation of SBTi, companies can reduce their greenhouse gas emissions in line with global carbon dioxide (CO_2) emission reduction targets.

This thesis explores the impact of SBTs on promoting corporate sustainability practices within the electrical equipment and machinery sector. Initially, the research examines the collective efforts of companies in innovative strategizing and highlights both opportunities and challenges faced by the thesis's collaborative partner company in their corporate environmental and sustainability strategies to meet their SBTs.

Utilizing both primary and secondary data, this thesis offers an in-depth analysis of the current sustainability strategies and objectives pursued by various companies. Primary data are sourced from empirical research methods, specifically through comparative analyses of semi-structured questionnaire interviews. Secondary data are derived from the SBTi database and companies' ESG reports. These methods are complemented by a comprehensive literature review, which discusses the SBTi, corporate sustainability strategies, Environ-mental, Social, and Governance (ESG) Reporting, as well as an analysis of Scope 3 emissions, Life Cycle Assessment (LCA), and the implications of green steel production and the Carbon Border Adjustment Mechanism (CBAM).

The key result of the research underscores the need to develop emission calculation methods. It also emphasizes the importance of reducing the carbon footprint of steel production by using recycled materials and the adoption of new emission reduction techniques. Enhanced supplier and customer engagement strategies concerning SBTs, as well as an analysis of the effects of the CBAM on supply chain processes, are also highlighted. Overall, this research advocates for a sustainable corporate environment, urging industries to balance business growth with sustainability goals.

Keywords CO_2 Emissions, Greenhouse Gas Emissions, Science-Based Target initiative, Scope 3 Emissions, Sustainability

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Tiivistelmä

Yritykset ovat maailmanlaajuisesti sitoutuneet Pariisin ilmastosopimuksen tavoitteisiin, pyrkiessään rajoittamaan ilmaston lämpenemisen alle 2 °C:seen, mieluiten 1,5 °C:seen, esiteolliseen tasoon verrattuna. Monet yritykset ovat omaksuneet Science Based Targets -aloitteen (SBTi), joka on perustettu yhteistyössä eri organisaatioiden välillä, kuten United Nations Global Compact (UNGC), Maailman luonnonsäätiö (WWF), World Resources Institute (WRI) ja Carbon Disclosure Project (CDP). SBTi:n avulla yritykset voivat vähentää kasvihuonekaasupäästöjään maailmanlaajuisten hiilidioksidin (CO_2) päästövähennystavoitteiden mukaisesti.

Tämä tutkimus käsittelee SBT:n vaikutusta yritysten kestävän kehityksen käytäntöjen edistämiseen sähkölaiteita ja koneistoja valmistavalla sektorilla. Tutkimus tarkastelee yritysten yhteisiä panostuksia innovatiivisten strategioiden suunnitteluun ja mallintaa mahdollisuuksia sekä haasteita yhteistyökumppaniyritykselle yrityksen ympäristöponnisteluissa ja kestävän kehityksen strategioissa SBT-tavoitteiden saavuttamiseksi.

Hyödyntämällä sekä ensisijaisia, että toissijaisia tutkimusmenetelmiä, tutkimus tarjoaa syvällisen analyysin eri yritysten asettamista nykyisistä kestävän kehityksen strategioista ja tavoitteista. Ensijaisena tutkimusmenetelmänä tutkimus hyödyntää vertailuanalyysejä puolistrukturoiduista kyselyhaastatteluista ja toissijaisena tutkimusmenetelmänä SBTi-tietokantaa sekä yritysten ESG-raportteja. Näitä menetelmiä täydentää kirjallisuuskatsaus, joka esittää näkökulmia SBTi-aloitteeseen, yritysten kestävän kehityksen strategioihin sekä ympäristö-, sosiaali- ja hallintotaparaportointiin (ESG), sekä analyysi Scope 3 -päästöistä, elinkaariarvioinnista (LCA) ja vihreän teräksen tuotannon ja hiilirajamekanismin (CBAM) vaikutuksista.

Tutkimus osoittaa tarvetta kehittää päästöjen laskentamenetelmiä ja vähentää terästuotannon hiilijalanjälkeä käyttämällä kierrätysmateriaaleja, uusia päästöjen vähentämismenetelmiä, toimittaja- ja asiakassitoutumisstrategioita SBT-tavoitteiden suhteen, sekä analysoimalla CBAM:n vaikutusta toimitusketjuprosesseihin. Tutkimus edistää kestävän kehityksen yritysympäristöä, kannustaen teollisuudenaloja sovittamaan yhteen liiketoiminnan kasvun ja kestävän kehityksen tavoitteet.

Avainsanat Hiilidioksidipäästöt, Kasvihuonepäästöt, Kestävä kehitys, Scope 3 -päästöt, Tieteeseen perustuvat ilmastotavoitteet -aloite

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Preface

I began my master's degree studies full-time in 2021 alongside my full-time daily work commitments. This decision was a personal test of my tolerance for stress and pressure. While starting this journey, my expectations for academic success were modest at best, given that more than six years had gone by since my last university-level studies. To my surprise, I did not just get through the courses but also managed to secure commendable grades. And now, with this thesis, I am close to completing my degree.

I would like to thank my supervisor, Assistant Professor Mahdi Pourakbari Kasmaei, and my thesis advisor, Lauri Vesterinen, M.Sc., for their valuable advice and guidance throughout my thesis journey. I also want to express my gratitude to my work colleagues, my peer students, friends, and family for their unwavering support during the thesis writing process. Additionally, I would like to thank my employer for supporting me in my daily work while pursuing my Master of Science degree, as well as the entire Aalto University teaching staff for providing me with a great foundation for my studies. Lastly, I want to thank all the interviewed individuals for their valuable insights and contributions to this thesis.

While battling against stress and exhaustion during my studies and work, I frequently recalled a quote from the Oscar-winning actor Denzel Washington: "Dreams without goals are just dreams and ultimately they fuel disappointment. On the road to achieving your dreams you must apply discipline but more importantly consistency. Because without commitment you will never start, but without consistency, you will never finish." By obeying these principles, I can finally say with joy that now I am finished!

Espoo, 17th of November 2023
Jonne Malmberg

Symbols and Abbreviations

Symbols

°C = Temperature in Degrees in Celsius
CO_2 = Carbon Dioxide
gCO_2/kWh = Carbon Dioxide Emission Intensity

Abbreviations

CBAM = Carbon Border Adjustment Mechanism
CCS = Carbon Capture and Storage
CDP = Carbon Disclosure Project
CSR = Corporate Social Responsibility
EAF = Electric Arc Furnace
EPA = Environmental Protection Agency
EPD = Environmental Product Declaration
ESG = Environmental, Social, and Governance
ETS = Emissions Trading System
EU = European Union
GHG = Greenhouse Gas
GRI = Global Reporting Initiative
ID = Identification
IPCC = Intergovernmental Panel on Climate Change
ISO = International Organization for Standardization
LCA = Life Cycle Assessment
LCIA = Life Cycle Impact Assessment
LCI = Life Cycle Inventory
LCSA = Life Cycle Sustainability Assessment
NGO = Non-Governmental Organizations
OR = Order Received
R&D = Research and Development
SASB = Sustainability Accounting Standards Board
SDG = Sustainable Development Goals
SBT = Science Based Targets
SBTi = Science-Based Targets initiative
SME = Small and Medium-sized Enterprises
TCFD = Task Force on Climate-related Financial Disclosures
UN = United Nations
UNGC = United Nations Global Compact
WRI = World Resources Institute
WTO = World Trade Organization
WWF = World Wide Fund for Nature

1 Introduction

Climate change and global warming have become pressing issues that demand urgent and collaborative action from governments, companies, and individuals worldwide. The Paris Agreement, signed in 2015, sets a goal to limit global warming to below 2°C, preferably to 1.5°C, above pre-industrial levels [1]. Therefore, companies across various industries are adopting Science Based Target initiative (SBTi) to reduce their greenhouse gas (GHG) emissions in line with the worldwide carbon reduction goals [2].

SBTi is a collaborative effort between the United Nations Global Compact (UNGC), the World Wide Fund for Nature (WWF), the World Resources Institute (WRI), and the Carbon Disclosure Project (CDP) [2]. SBTs are specific, measurable objectives set by companies to align their GHG emissions reduction efforts with the Paris Agreement's goals. These targets are based on the latest climate science, incorporating assessments from the Intergovernmental Panel on Climate Change (IPCC), and are determined in a way that is proportionate to each company's contribution to global emissions [3]. They take into account a company's sector, geography, and business model to create a tailored strategy for emissions reduction [2].

Defined as the indirect GHG emissions that occur in a company's value chain, Scope 3 emissions include those from procured goods and services, transportation and distribution, operational waste, and the use of sold products [4]. As reported by the GHG Protocol, Scope 3 emissions can constitute most of a company's total GHG emissions [4]. The substantial share of Scope 3 emissions underscores their crucial role in corporate sustainability and climate change mitigation efforts, necessitating a deeper understanding of their intricacies and ways to effectively manage them. Therefore, SBTi promotes setting targets to reduce these emissions. However, managing these emissions presents challenges in boundary definition, organizational constraints, methodology, and data collection [5].

Data collection is complicated due to the Scope 3 emissions typically originating outside the direct operational control of the company [5]. Moreover, the methodology for quantifying Scope 3 emissions remains contentious without a universally accepted approach, leading to significant discrepancies in emission estimates [6]. Depending on the operations and supply chain of each company, the nature of boundary definition can drastically affect the total emissions and subsequent targets set by a company [7]. Organizational constraints, such as lack of internal resources or the complexity introduced by stakeholders with varying environmental strategies, further impede the efficient management of Scope 3 emissions [8].

The thesis collaborative partner company (referred as Company 1) operates extensively in the electrical equipment and machinery sector. Company 1 has committed to reducing its GHG emissions by 50% by 2030, with a focus

on Scope 1 and 2 emissions and a 40% reduction in Scope 3 emissions over the same target period, relative to orders received. The company's ambitious climate targets include achieving carbon-neutral operations by 2030 [9]. Considering the significance of these goals and challenges in managing Scope 3 emissions, it is essential for Company 1 to enhance understanding and implementation of effective corporate sustainability strategies.

The research methodology of this thesis utilizes a qualitative approach, initiated with a theoretical phase informed by a comprehensive literature review, followed by an empirical phase. This empirical phase will analyze annual Environmental, Social, and Governance (ESG) reports of selected companies, conduct semi-structured interviews with these companies, and review the SBTi database to gather relevant data and identify best practices for corporate sustainability strategies in the electrical equipment and machinery sector. Empirical findings will be analyzed using a constant comparison method, and insights derived from both the literature review and case studies based on semi-structured interviews will be consolidated through an integrative cross-case analysis.

This thesis aims to enhance the climate change prevention efforts of companies in the electrical equipment and machinery sector, focusing on SBTi actions at the Scope 3 level within corporate and supplier environmental policies. The expected outcome is a set of recommendations for companies to improve their Scope 3 emissions SBT action plans, adopting best practices and innovative strategies, while addressing challenges in supplier engagement, emission calculation, and reporting. Ultimately, this research contributes to advancing corporate sustainability by evaluating strategies that can effectively help manage and reduce Scope 3 emissions through evidence-based approaches and strengthened supplier collaboration.

The remainder of this thesis is structured as follows. Chapter 2 reviews the literature on SBTi, Scope 3 emissions, corporate sustainability policies, and emission reduction strategies, and examines methods to reduce Scope 3 emissions along with aspects of corporate and supplier engagement. Chapter 3 outlines the methodology, combining a literature review with empirical analysis of ESG reports and SBTi database data, and includes semi-structured interviews with selected companies and a questionnaire survey with Company 1’s suppliers. Chapter 4 provides an analysis of the collected data, offering insights into the effectiveness of Company 1’s existing Scope 3 emissions reduction strategies. Chapter 5 presents the results, focusing on the impact of the Carbon Border Adjustment Mechanism (CBAM) on companies' supply chains, enhancements in Scope 3 emission calculations, supplier engagement, customer expectations, and green steel initiatives. Finally, Chapter 6 concludes the thesis with a summary of findings and suggestions for future research on topics such as SBTi transparency, Scope 3 reliability, supplier collaboration, corporate sustainability, and the role of emerging technologies in emission reduction.

2 Literature Review

This chapter presents a comprehensive literature review, covering areas such as the Science-Based Targets initiative, corporate sustainability policies, the challenges associated with managing and reducing Scope 3 emissions, and the principles of Environmental, Social, and Governance (ESG) reporting. Additionally, it examines the measurement and calculation of Scope 3 emissions, especially within categories 1 and 11 and the significance of Life Cycle Assessment (LCA) in this context. The chapter also reviews best practices for corporate engagement in reducing Scope 3 emissions, offering insights into the vital role supplier engagement plays in these reduction efforts. Throughout the review, connections are drawn between the presented concepts and extant research to provide a holistic understanding of the current landscape.

2.1 The Science-Based Targets Initiative

The Science-Based Targets initiative (SBTi) is a collaboration between the United Nations Global Compact (UNGC), The World Wide Fund for Nature (WWF), the World Resources Institute (WRI), and the Carbon Disclosure Project (CDP). It was established in 2015 following the Paris Agreement, which endeavored to control global warming by keeping the temperature increase below 2°C, compared to pre-industrial levels. [2]

SBTi guides and supports organizations to set Science Based Targets (SBTs), ensuring their greenhouse gas (GHG) reduction commitments correspond to the rate of decarbonization required to reach the goals of the Paris Agreement. Furthermore, SBTi provides a solid validation procedure to maintain the credibility and integrity of the targets [10]. The targets are founded on the latest climate science, including the IPCC assessments, and should be proportionate to each company's contribution to global emissions [11]. The development of SBTs includes an understanding of a company's sector, geography, and business model to ensure an appropriate strategy for emission reduction [2].

The SBTi provides guidance on setting SBTs across three different scopes of emissions: Scope 1, Scope 2, and Scope 3 [12]. Scope 1 emissions are direct emissions from a company's operations, such as those from burning fossil fuels in a factory or office. Scope 2 emissions are indirect emissions from the generation of purchased electricity, heat, or steam consumed by a company. Scope 3 emissions are indirect emissions that occur outside of a company's own operations, such as those from the production and transportation of purchased goods and services, as seen in Figure 1 [4], [13].

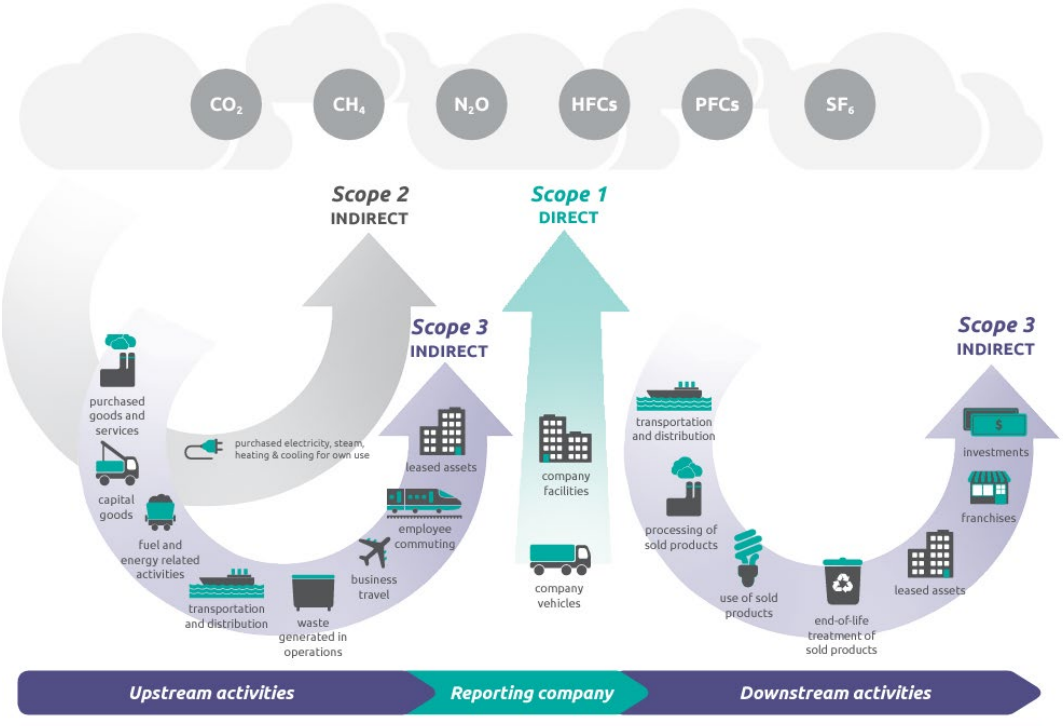

Figure 1. Overview of the distribution of GHG Protocol scopes and emissions across the value chain [4].

The SBTi encourages companies to set targets that cover all three scopes of emissions [4]. The SBTi provides guidance on how to set targets for each scope of emissions, including methodologies for calculating emissions, setting reduction targets, and selecting appropriate base years [2]. SBTs have emerged as a key tool for driving corporate sustainability, as they provide a clear and measurable pathway for companies to reduce their carbon footprint and contribute to global climate goals [13].

The commitment to SBTs among companies has seen a dramatic increase in recent years. As of December 2021, over 2,000 companies, inclusive of some of the world's largest corporations, had pledged their commitment to setting SBTs [14]. This commitment grew rapidly over the next year and a half. By the end of 2022, the number of companies engaged in SBTs had increased to over 4,000, indicating a significant and continual rise in the adoption of SBTs by corporations worldwide [15]. This momentum has continued, as evidenced by the fact that by mid-2023, the total number of companies committed to SBTs had further risen to 5,580. The year-by-year growth in SBT commitments and approved targets is presented in Figure 2.

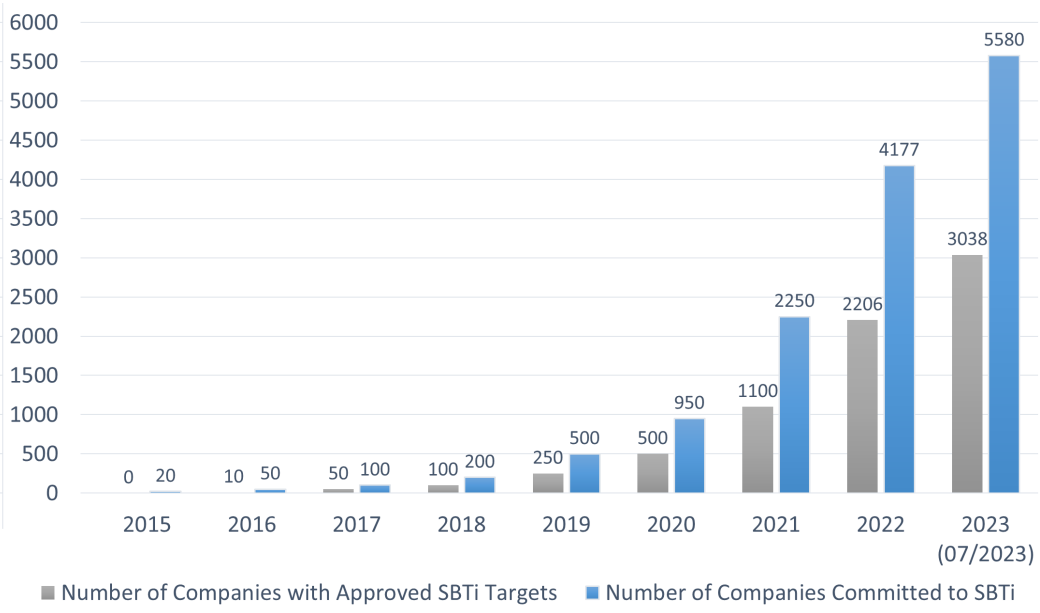

Figure 2. Number of companies committed to SBTi and with approved targets [16], [17].

2.1.1 Challenges and Opportunities of SBTs

Despite their potential benefits, the adoption of SBTs also presents several challenges for companies. One of the main challenges is data collection, as the calculation of GHG emissions across the value chain can be complex and resource-intensive [4]. Companies must also engage their suppliers and partners to gather data on Scope 3 emissions, which can be challenging due to the lack of transparency and standardization in supply chains [17]. To address this challenge, companies may need to invest in new technologies and systems for tracking emissions data and engaging with suppliers and partners.

Another challenge associated with SBTs is internal resistance from employees and management, who may not see the immediate benefits of adopting SBTs [18]. To overcome this challenge, companies may need to invest in internal communications and engagement strategies to educate employees and build support for the adoption of SBTs [19]. Companies can also consider setting up incentives for employees to encourage participation in sustainability initiatives [20]. In addition, companies may struggle to balance the need for aggressive emissions reduction targets with their financial performance and long-term growth prospects [18]. Companies may need to explore innovative financing mechanisms and business models that enable them to invest in emissions reduction measures while maintaining their financial performance [18], [19].

Despite these challenges, the adoption of SBTs offers numerous opportunities for companies that align their sustainability goals with their core business strategy and operations. One significant opportunity is to demonstrate industry leadership by setting ambitious SBTs aligned with global climate goals [13]. Companies that set ambitious and credible SBTs signal to investors, customers, and employees that they are committed to long-term sustainability and are well-positioned to navigate the transition to a low-carbon economy [15]. This action can improve a company's reputation and enhance its brand value, which can be particularly important for consumer-facing companies.

Another opportunity is to drive innovation and operational efficiency by identifying and implementing GHG reduction measures throughout the value chain [21]. This approach can lead to cost savings, improved supply chain resilience, and increased competitiveness in a rapidly changing business environment [22]. By aligning emissions reduction strategies with operational improvements, companies can identify inefficiencies in their processes and resource use. Streamlining operations and investing in cleaner technologies often lead to reduced waste, lower energy consumption, and optimized resource utilization. As a result, companies not only cut down their emissions but also reduce their operational costs, leading to direct cost savings in the long run [22]. Additionally, the adoption of SBTs can help companies identify and manage climate risks, such as extreme weather events or regulatory changes, which can significantly impact their operations and bottom line [13].

2.1.2 Criticism Towards SBTi

SBTs have gained significant traction in recent years, led by the establishment of the SBTi. However, several concerns and criticisms underline the discussions about SBTi's efficacy and implementation [23]. These criticized areas in SBTi are:

Complexity of The Target-Setting Process

One of the criticisms towards the SBTi is the complexity of the target-setting process [16]. The SBTi requires companies to set targets that align with the goals of the Paris Agreement, which involves determining the appropriate level of ambition for emissions reduction based on a company's sector and emissions profile [24]. This can be a challenging and time-consuming process for companies, particularly for those with limited resources or expertise in emissions reduction strategies. Critics argue that the complexity of the target-setting process may discourage companies from adopting SBTs or result in targets that are too low to effectively mitigate climate change. A study by Bjørn et al. [23] found that the complexity of the SBTi methodology and target-setting process was a barrier to adoption for many companies, particularly small- and medium-sized enterprises

(SMEs). Additionally, some critics argue that the methodology used by the SBTi is not transparent and that the criteria used to determine the level of ambition for targets is not clearly defined [23].

Lack of Inclusivity

Another criticism towards the SBTi is the lack of inclusivity in the target-setting process. While the SBTi has established sector-specific target-setting methods, some critics argue that the methodology is not inclusive enough to address the diversity of companies and industries worldwide [24]. Furthermore, the SBTi has been criticized for not engaging with stakeholders beyond the business sector, such as civil society groups and communities affected by climate change [25]. This lack of inclusivity may limit the effectiveness of SBTs in achieving the global goals of the Paris Agreement and addressing the complex social and environmental challenges associated with climate change [26].

Inadequate Verification Processes

Critics have pointed towards the processes for target-setting and progress reporting within the SBTi as potentially inadequate. While the SBTi requires companies to report on their progress towards achieving their targets, some critics argue that the verification processes used by the SBTi are not rigorous enough to ensure the accuracy and transparency of reported data [27], [28]. Additionally, some critics argue that the SBTi does not adequately address the issue of "double counting," which occurs when emissions reductions are claimed by multiple parties, leading to an overestimation of overall reduction efforts [28]. Without adequate verification processes, the credibility and effectiveness of SBTs may be undermined, and companies may be incentivized to engage in "greenwashing" or misleading claims regarding their emissions reductions [29].

2.2 Corporate Sustainability Policies

Corporate sustainability policies are increasingly becoming a crucial aspect of business strategy [30]. These policies are formulated from guidelines, principles, and practices, which are meticulously designed to incorporate ESG considerations into a company's operations and decision-making processes. They cover a wide range of sustainability aspects, including resource management, climate change mitigation, community engagement, and ethical governance [31]. Such broad coverage ensures that, through the implementation of effective sustainability policies, companies not only can drive positive change but also significantly contribute to the United Nations Sustainable Development Goals (SDGs) that are seen in Figure 3 [32].

Figure 3. A diagram listing the UN 17 Sustainable Development Goals [32].

The United Nations Sustainable Development Goals (SDGs) are a set of 17 interconnected goals that serve as a detailed plan for creating a sustainable future for everyone by 2030 [32]. These goals encompass a wide range of sustainability issues, from poverty reduction and health to education, clean water and sanitation, affordable clean energy, sustainable cities and communities, responsible consumption and production, and climate action, among others [32]. By aligning corporate sustainability policies with the SDGs, companies take a strategic approach to creating a sustainable future. This commitment not only enables companies to demonstrate leadership in sustainability, enhance stakeholder engagement, and create shared value, but it also allows them to measure and communicate their contributions towards these global goals, thereby increasing transparency and accountability [31]. The SDGs also present companies with numerous opportunities to innovate, collaborate, and access new markets, thereby strengthening their competitive advantage while promoting global sustainability.

Corporate sustainability policies guide organizations towards a trajectory of balanced, sustainable growth that aligns with broader societal and environmental concerns. This alignment ensures long-term value creation for all stakeholders [33]. Stakeholders often demand that companies provide non-financial information alongside traditional financial reporting [33]. Sustainability reporting, the practice of measuring and disclosing a company's social and environmental performance, both short- and long-term, supports the control of business operations and ensures accountability to stakeholders [34], [35]. Effective communication with stakeholders is be-

coming a defining characteristic of corporate responsibility in the 21st century [36].

2.2.1 The Role of Corporate Sustainability Policies in Business Strategy

Companies that align their business strategy with robust sustainability policies are more likely to be strategic, mature, and long-term-oriented, thereby enhancing competitiveness and supporting societal well-being [33]. These policies enable companies to better manage risks, capitalize on opportunities, and create long-term value for stakeholders [38]. The effectiveness of corporate governance, accountability, and transparency are becoming increasingly critical in sustainability reporting and disclosure [34].

By adopting sustainability policies, companies can enhance their reputation, attract and retain talent, and improve operational efficiency through resource conservation and waste reduction. Furthermore, such policies can lead to innovation and new business opportunities, as companies develop products and services that cater to the growing demand for sustainable solutions. This proactive approach to sustainability not only benefits the environment but also improves the company's standing among stakeholders and the public. [38]

Developing effective corporate sustainability policies requires a comprehensive approach that considers various ESG factors and stakeholder expectations. Best practices in this area include [39]:

- Assessing material ESG risks and opportunities relevant to the company's operations and industry.
- Establishing clear goals and targets aligned with the SDGs and other relevant sustainability frameworks.
- Engaging with stakeholders, including employees, investors, customers, and communities, to gather feedback and ensure their concerns are addressed.
- Integrating sustainability policies into the company's overall strategy, decision-making processes, and governance structure.
- Regularly monitoring, evaluating, and reporting on the company's sustainability performance to ensure continuous improvement and transparency.

2.2.2 Challenges in Implementing Corporate Sustainability Policies

Despite the growing recognition of the importance of corporate sustainability policies, companies often find themselves wrestling with numerous challenges when it comes to implementing them. These challenges cover several areas [40]:

- Striking a balance between short-term financial objectives and long-term sustainability goals. This necessitates a careful examination of the company's priorities and a willingness to invest in long-term sustainable practices that may not yield immediate financial gains.
- Ensuring effective communication and coordination among different departments and business units. The successful implementation of sustainability policies often hinges on clear and consistent communication to ensure all divisions of the company understand and commit to these policies.
- Overcoming resistance to change and fostering a culture of sustainability within the organization. This may involve addressing concerns, providing training, and demonstrating the benefits of sustainable practices to win over sceptics.
- Managing the increasing complexity of sustainability issues and staying up to date with the rapidly evolving regulatory landscape. Companies need to keep pace with current trends, innovations, and regulations related to sustainability to ensure their policies remain effective and compliant.

2.2.3 Corporate Social Responsibility (CSR)

The principle of Corporate Social Responsibility (CSR) incorporates ecological and societal considerations into the core operations and stakeholder interactions of a business. It represents the company's promise to act responsibly, promoting societal progress while simultaneously enhancing the life quality of its employees and their dependents, along with the broader community and society in general. [33]

CSR intersects with corporate sustainability policies in several key areas, and effectively incorporating it can strengthen a business's overall sustainability strategy as follows.

Ethical Business Practices
CSR often involves a commitment to maintaining high ethical standards in all aspects of a company's operations. This can cover a wide range of issues, from anti-corruption measures to fair trade practices, which contribute to a more sustainable and socially responsible business environment. [40]

Employee Welfare
CSR policies often include commitments to employee health and safety, fair wages, diversity, and inclusivity. Such practices can significantly contribute to a company's sustainability objectives, enhancing its reputation as a responsible employer and attracting high-quality talent. [30]

Community Engagement:
Companies with a strong CSR policy are often deeply involved in their local communities, investing in social initiatives, partnering with local organizations, or sponsoring community-based programs. These activities contribute to societal development, an integral part of the sustainability agenda. [30]

Environmental Responsibility
CSR encourages companies to minimize their environmental impact, promote resource conservation, and adopt eco-friendly practices. This directly aligns with the environmental component of corporate sustainability, helping companies to mitigate their environmental risks and contribute to global sustainability efforts. [40]

Implementing CSR effectively can be a complex process, with challenges including aligning CSR initiatives with core business strategy, ensuring transparency in reporting CSR activities, and managing stakeholder expectations. Therefore, the integration of CSR into corporate sustainability policies can also present a multitude of opportunities. These may include strengthening relationships with stakeholders, enhancing corporate reputation, creating competitive advantages, and contributing to long-term profitability. [40]

2.3 Environmental, Social, and Governance (ESG) Reporting

In today's corporate landscape, Environmental, Social, and Governance (ESG) reporting has become an indelible aspect of corporate transparency and accountability, asserting its influence and importance. It serves as a critical linkage within the broader framework of corporate sustainability, bridging the gap between SBTs and the crucial task of reducing Scope 3 emissions. [41]

ESG reporting elevates the importance of sustainable operations and environmentally conscious policies within corporate structures. It also actively promotes comprehensive engagement of stakeholders, involving them in the process and providing them with pertinent information. This allows or-

ganizations to gain valuable insights and feedback, fostering an interactive environment that promotes sustainability. [42]

2.3.1 Understanding ESG Reporting

The integration of ESG factors into corporate decision-making has been recognized to identify and manage risks, seize opportunities, and enhance long-term value creation. ESG reporting plays a crucial role in communicating a company's sustainability performance, both to internal and external stakeholders. Specifically, ESG reporting can help companies track and report their progress towards SBTs and facilitate the reduction of Scope 3 emissions. [43]

There are various standards and frameworks available for ESG reporting, such as the Global Reporting Initiative (GRI), the Sustainability Accounting Standards Board (SASB), and the Task Force on Climate-related Financial Disclosures (TCFD). Each framework provides guidance on how to report ESG factors such as GHG emissions, resource consumption, and social aspects of sustainability. The ESG reporting movement aims to bring ESG practices into mainstream business, but there is a disconnect between financial and ESG information. [44]

The global focus on how ESG disclosures affect financial outcomes has led to an increase in ESG declaration and the use of reporting tools worldwide [45]. This trend is evident particularly in many European countries where the disclosure of non-financial data has now become a compulsory requirement [45]. The evolution of global norms for sharing sustainable development information, which focuses on the needs of investors and financial markets, has prompted the standardization of ESG reporting and the development of new sustainability reporting standards within Europe [46].

The formulation of ESG measures is connected to an array of quantification procedures and the authority attributed to these measures [47]. However, despite the increasing adoption of ESG reporting, several challenges persist. These include the lack of standardized reporting formats, the complexity of data collection and analysis, and the potential for greenwashing [48]. To address these challenges, companies should strive for transparency, utilize third-party assurance, and engage in continuous improvement of their reporting practices [49].

2.3.2 The Role of ESG Reporting

Effective ESG reporting can play a significant role in fostering meaningful stakeholder engagement. Transparent ESG reporting allows stakeholders to

make informed decisions, engage in productive dialogues with companies, and hold them accountable for their actions. This transparency can lead to stronger relationships and shared value creation for all parties involved. [38]

When incorporated into corporate strategy, ESG factors can lead to better risk management, operational efficiency, and improved stakeholder relationships [50]. By aligning their strategic objectives with ESG principles, companies can create a more resilient and sustainable business model [38]. ESG reporting can serve as a valuable tool in this process, enabling organizations to monitor their progress towards sustainability goals, identify areas for improvement, and communicate their commitment to responsible business practices [38].

Investors are increasingly considering ESG factors in their decision-making processes. High-quality ESG reporting has become an essential component of attracting investment and maintaining investor confidence [50]. Companies with strong ESG performance are more likely to outperform their peers in the long term [51]. By providing comprehensive, accurate, and transparent ESG disclosures, companies can demonstrate their commitment to sustainability and responsible business practices, thereby appealing to a broader range of investors and accessing new sources of capital [51].

2.4 Scope 3 Emissions

Scope 3 emissions can be defined as indirect GHG emissions that occur in a company's value chain. These emissions include those from procured goods and services, transportation and distribution, operational waste, and the use and disposal of sold products as seen in Figure 1 [4]. As reported by the GHG Protocol, a globally recognized framework for measuring and managing greenhouse gas emissions, Scope 3 emissions can constitute the majority of a company's total GHG emissions as seen in Figure 4 [4], [9]. The significant proportion of Scope 3 emissions highlights their essential role in corporate sustainability and climate change mitigation. It necessitates a comprehensive understanding and effective management of these emissions [52].

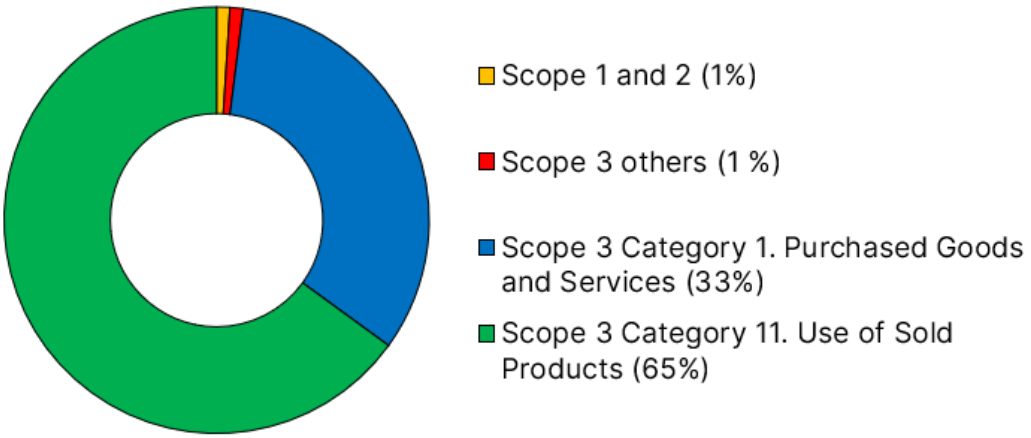

Figure 4. Company 1's total GHG emissions in 2022 [9].

2.4.1 Scope 3 Emission Categories

The GHG Protocol categorizes Scope 3 emissions into 15 distinct categories. Each of these represents different sources of indirect emissions within a company's value chain [4]:

1. Purchased Goods and Services: This encompasses emissions from the production of goods and services procured or acquired by the reporting company.
2. Capital Goods: This pertains to emissions derived from the production of capital goods such as equipment and buildings used by the reporting company.
3. Fuel- and Energy-Related Activities: This includes emissions resulting from the production, transportation, and distribution of fuels and energy purchased by the company, excluding those considered Scope 1 and 2 emissions.
4. Upstream Transportation and Distribution: This refers to emissions associated with the transportation and distribution of goods and materials used in the company's operations.
5. Waste Generated in Operations: This involves emissions from the disposal, treatment, and recycling of waste generated by the reporting company's operations.
6. Business Travel: This covers emissions from employee business travel, including air, rail, and road transportation.
7. Employee Commuting: This relates to emissions from employees commuting to and from work.
8. Upstream Leased Assets: This includes emissions from the operation of assets leased by the reporting company, not considering Scope 1 and 2 emissions.

9. Downstream Transportation and Distribution: This involves emissions from the transportation and distribution of goods and materials after they leave the reporting company's control.
10. Processing of Sold Products: This refers to emissions from the processing, use, or treatment of products sold by the reporting company.
11. Use of Sold Products: This covers emissions from the use of products or services provided by the reporting company.
12. End-of-Life Treatment of Sold Products: This involves emissions from the disposal, treatment, and recycling of products sold by the reporting company once they reach the end of their useful life.
13. Downstream Leased Assets: This refers to emissions from the operation of assets leased to others, excluding Scope 1 and 2 emissions.
14. Franchises: This includes emissions from the operation of franchises associated with the reporting company.
15. Investments: This pertains to emissions from investments made by the reporting company, such as equity investments and debt financing.

The detailed understanding of these categories is crucial for companies to effectively monitor, manage, and reduce their Scope 3 emissions. By identifying the major contributors to their total emissions, companies can target their sustainability efforts more effectively and create strategies that align with their specific value chains. [4]

2.4.2 Managing Scope 3 Emissions

The management of Scope 3 emissions is a complex task riddled with challenges, primarily due to the intricate nature of data collection and reporting. The complexities stem from the extensive coverage of Scope 3 emissions across multiple stages in the value chain, necessitating inputs from a variety of stakeholders such as suppliers. Methodological complexities amplify these challenges, with issues arising in defining the boundaries of emissions, identifying appropriate emissions factors, and accounting for changes in the value chain over time. [53]

Despite these challenges, effective management of Scope 3 emissions can present opportunities to improve environmental performance and strengthen relationships with stakeholders, such as suppliers. By actively engaging suppliers and aiming for emissions reductions across the value chain, corporations can bolster their reputation and mitigate climate-related risks. [54]

Several established frameworks and standards aid corporations in managing Scope 3 emissions. The GHG Protocol offers guidelines for measuring

and reporting greenhouse gas emissions across the value chain [4]. The Corporate Value Chain (Scope 3) Accounting and Reporting Standard, extension of the GHG Protocol, provides an exhaustive framework for calculating and reporting Scope 3 emissions [4]. Another salient framework is the ISO 14064-3 standard, which offers guidelines for quantifying and reporting greenhouse gas emissions and removals at the organizational level [55].

2.4.3 Category 1. Purchased Goods and Services

As mentioned earlier, Category 1, Purchased goods and services, encompasses emissions from the production of goods and services procured by a company [4]. These emissions are essential to consider because they often constitute a significant portion of a company's indirect output. In many cases, companies have limited control over the emissions generated from purchased goods and services. However, by understanding and managing these emissions, companies can engage with their suppliers to reduce their environmental impact and strengthen their supply chain's sustainability [56].

One of the significant challenges in managing emissions from purchased goods and services is obtaining accurate data from suppliers. This challenge involves requesting data from multiple suppliers and ensuring the accuracy and completeness of the data [4]. Companies can address this challenge by engaging with their suppliers and setting up supplier engagement programs that encourage transparency and sharing of best practices [53].

Another challenge in managing emissions from purchased goods and services is finding ways to reduce emissions without compromising the quality of the products or services. Companies can address this challenge by implementing sustainable procurement strategies. These may include selecting suppliers with lower emissions profiles, incorporating environmental criteria in procurement decisions, and working collaboratively with suppliers to enhance their environmental performance [4]. However, adopting sustainable procurement strategies can lead to increased costs, often due to the higher prices of eco-friendly materials and the enhanced resource utilization required for their production and implementation [56].

2.4.4 Category 11. Use of Sold Products

The use of sold products covers emissions resulting from the consumption or use of a company's products by end-users. These emissions can be significant, especially for companies producing energy-intensive products, such as electronics or automobiles. By understanding and managing emissions from the use of sold products, companies can identify opportunities to re-

duce their products' environmental impact and develop more sustainable products. [4]

One of the main challenges in managing emissions from the use of sold products is influencing consumer behavior [4]. Companies often have limited control over how their products are used and the resulting emissions. However, companies can influence consumer behavior by designing products that are more energy-efficient, durable, and easy to repair or maintain, thereby reducing emissions during the usage phase [57].

Another challenge lies in the complexity of measuring emissions from the use of sold products. It requires tracking product usage and estimating emissions over the product's entire life cycle using Life Cycle Assessment (LCA) [57]. LCA can help companies address this challenge by providing a comprehensive view of a product's environmental impact throughout its life cycle, from raw material extraction to end-of-life disposal. By using LCA, companies can identify hotspots in their products' life cycles where emissions can be reduced and focus their efforts accordingly [58].

Innovative strategies for reducing emissions from the use of sold products include eco-design approaches that prioritize energy efficiency, durability, and recyclability [59]. Companies can also explore product-service systems that shift the focus from selling products to providing services that meet consumers' needs while reducing emissions [60]. For example, a company could offer product leasing or sharing services instead of selling products outright, reducing the overall number of products produced and lowering emissions from the use of sold products [60].

2.4.5 Challenges of Reducing Scope 3 Emissions

Scope 1 and 2 carbon emissions have long been at the forefront of carbon management strategies. Yet, an increasingly significant portion of a company's carbon footprint is being recognized to stem from its value chain as Scope 3 emissions. Therefore, the effective management of these emissions is increasingly critical in our carbon-constrained world [61]. The reduction of Scope 3 emissions presents an intricate challenge, largely due to the complexity inherent in collaborating with a broad range of stakeholders, such as suppliers, customers, and other value chain partners [61]. This complexity is compounded by several key factors as follows.

Lack of Control and Influence
The limited control and influence companies exert over their value chain partners constitute one of the primary barriers to reducing Scope 3 carbon emissions. Companies with extensive and complex value chains struggle

with this challenge, as their emissions reduction potential often relies on third-party actions [62]. A potential solution is developing collaborative relationships with value chain partners. This collaboration enables companies to work jointly on emissions reduction strategies, which could include data and information sharing, research, and development (R&D) collaboration, and joint investment in emissions reduction initiatives [63].

Data Collection and Reporting

Collecting and reporting accurate data represent another significant challenge for reducing Scope 3 carbon emissions. The process of measuring Scope 3 emissions, as detailed in Chapter 2, can be intricate and time-consuming, necessitating data procurement from multiple sources across the value chain. Insufficient or inaccurate data impairs identifying and resolving emissions hotspots and hinders tracking progress towards reduction targets. One-way companies can tackle this issue is by collaborating with value chain partners to enhance data collection and reporting processes. Developing standardized data collection tools, establishing clear communication channels, and providing training and support to suppliers and other stakeholders could be part of these collaborative efforts. [62]

Cost and Resource Constraints

The reduction of Scope 3 carbon emissions can be both costly and resource-intensive, which often impedes companies from making necessary investments in new technologies, business practice modifications, or collaborative emissions reduction initiatives. Justifying such investments can be particularly challenging for companies operating in highly competitive markets or those under financial strain. Creating compelling business cases for emissions reduction initiatives can serve as a strategic approach to mitigate this constraint. These cases could highlight potential financial benefits of emissions reduction, including energy efficiency improvements, risk mitigation from climate-related events, and enhancements in brand reputation and customer loyalty. [64]

Lack of Incentives

The scarcity of incentives for companies to invest in emissions reduction initiatives represents another challenge in decreasing Scope 3 carbon emissions. Without a clear business case or assurance of recognition for their efforts, companies may hesitate to engage in such initiatives. Governments, industry associations, and other stakeholders can intervene to offer incentives encouraging companies to reduce their Scope 3 carbon emissions. These incentives could range from financial ones, such as tax credits or subsidies, to non-financial benefits like public recognition or certification for emissions reduction achievements. [65]

2.5 Life Cycle Assessment (LCA)

Life Cycle Assessment (LCA) is a globally recognized, comprehensive technique for determining the environmental footprint of a product, process, or service. It encompasses every stage of existence, from the extraction of raw materials, manufacturing, distribution, use, to end-of-life disposal or recycling [58], as shown in Figure 5. This broad spectrum of assessment provides companies with a deep understanding of the different stages of their products or services' life cycles that generate significant environmental impacts. Therefore, it helps pinpoint areas where mitigation strategies can be implemented for reducing these impacts [66].

Born out of the need to understand and improve the energy efficiency of products in the early 1970s, LCA has steadily matured and become an indispensable tool for various sectors [58]. It has moved beyond just being an evaluative tool for assessing energy use to a comprehensive and dynamic methodology that considers a wide array of environmental concerns such as climate change, ozone layer depletion, water and air pollution, waste generation, and land use changes [67].

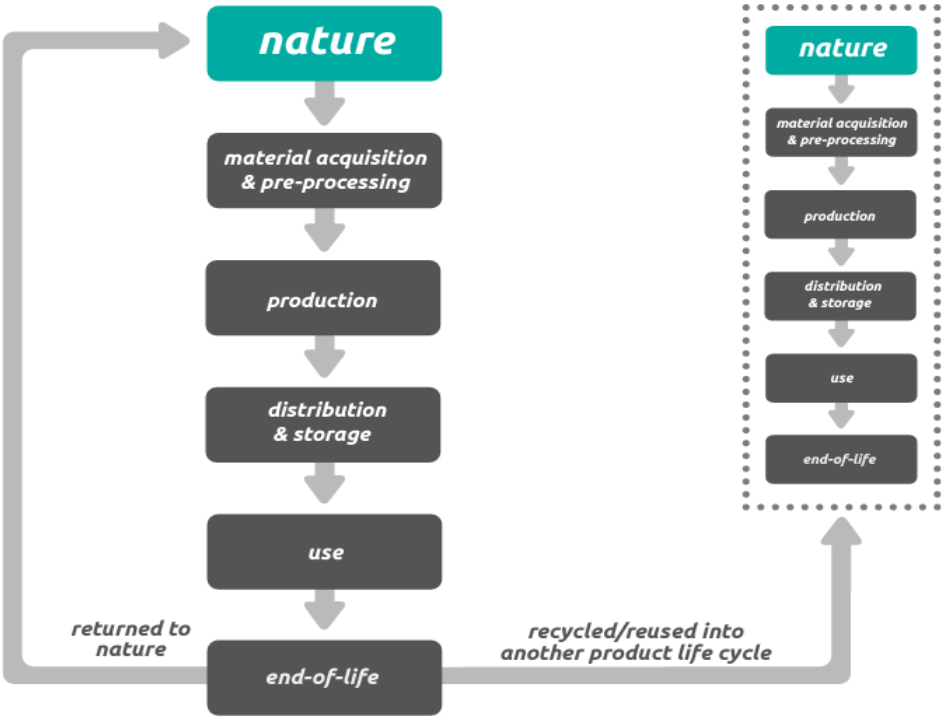

Figure 5. The five stages of a product life cycle [57].

2.5.1 Applications of LCA

LCA is used globally across numerous sectors and activities, like manufacturing, food, energy, construction, and transportation. It plays a key role in multiple domains such as policymaking, product design, strategic planning, and marketing. [68]

In policymaking, LCA serves as an essential tool for aiding decision-makers in identifying environmentally friendly alternatives by presenting potential environmental implications of different policy options. In strategic planning, LCA enables companies to identify environmentally problematic areas in their product life cycles, thereby guiding them to find alternatives for reducing these impacts. In the field of product development and improvement, LCA serves as an important tool in the creation of green products by assessing and minimizing environmental impacts throughout a product's life cycle. It offers data on environmental hotspots, empowering designers and engineers to target areas where they can make substantial improvements. [69], [70]

LCA is also increasingly leveraged in public procurement to assist officers in making environmentally sound purchasing decisions [70]. Furthermore, in the field of marketing, LCA enables eco-labelling, environmental product declarations (EPDs), and other forms of communication about the environmental attributes of products or services, thus providing transparent information about a product's environmental performance and facilitating a competitive advantage. [69], [71]

LCA plays a crucial role in the establishment and monitoring of SBTs. In the era of growing sustainability concerns and increasing pressure from stakeholders to minimize environmental impacts, LCA has also found relevance in the realm of corporate sustainability strategies [72]. It provides a structured and internationally recognized methodology for quantifying Scope 3 emissions. By identifying these emissions using an LCA, companies can develop targeted reduction strategies [73]. Moreover, tracking progress towards SBTs requires consistent and transparent measurement of GHG emissions over time. The methodological principles of LCA make it a suitable tool for this task, allowing companies to demonstrate the effectiveness of their GHG reduction strategies credibly [74].

2.5.2 Environmental Product Declaration (EPD)

EPDs represent application of LCA in the field of marketing and consumer information. EPDs provide a standardized and transparent way to communicate the environmental performance of a product or service. These

declarations are based on independently verified life cycle assessment data, offering a comprehensive perspective on the product's environmental impact across multiple dimensions, including resource use, emissions, waste generation and recycling. This allows consumers and companies to make more informed, environmentally conscious purchasing decisions. EPDs can enhance a company's environmental credibility and commitment to sustainability, serving as a key differentiation factor in competitive markets. [75]

The process of creating an EPD begins with conducting an LCA to determine the environmental impact of a product or service. This data, along with other relevant environmental information, are compiled and independently verified to ensure accuracy and validity. The verified information is then registered in a publicly accessible database in the form of an EPD. [75]

2.5.3 Methodology of LCA

The International Organization for Standardization (ISO) has delineated a four-phase methodology for conducting an LCA in the ISO 14040 and 14044 series [58]:

1. **Goal and Scope Definition Stage:** This initial stage determines the aims, targeted audience, and contextual framework of the LCA. It establishes system boundaries which indicate the processes to be included in the study, covering any stage from raw material procurement to disposal or manufacturing. A reference unit, known as the functional unit, is set at this stage to standardize all inputs, outputs, and potential environmental impacts, thereby enabling equitable comparisons across various systems.
2. **Life Cycle Inventory (LCI) Stage:** In LCI, all pertinent inputs (e.g., energy and raw materials) and outputs (e.g., emissions and waste) tied to the product's life cycle are recognized. The stage involves creating a model representing the technical system's flows, specifying system boundaries and interrelations among components, and assembling a categorized inventory table of material and energy fluxes.
3. **Life Cycle Impact Assessment (LCIA) Stage:** In this phase, the potential environmental impacts resulting from the inputs and outputs identified in the LCI are assessed. The process entails selecting relevant impact categories, defining category indicators, and choosing suitable characterization models. The LCI results are then classified, and category indicator results are calculated.

4. **Interpretation Stage:** This concluding stage necessitates a systematic evaluation of the results derived from the inventory analysis and impact assessment within the frame of the defined goal and scope. This includes conducting sensitivity and uncertainty analyses for validation purposes, articulating conclusions, discussing any limitations, and suggesting recommendations for potential system enhancements.

2.5.4 Challenges of LCA

With the advancement in computational capacities and the availability of comprehensive databases, the application of LCA has grown more sophisticated and accurate [76]. It continues to evolve, incorporating new dimensions of assessment, like social and economic factors, advancing towards a life cycle sustainability assessment (LCSA) [77].

Data availability is an issue for conducting LCAs for complex, global products, or services. The choice and definition of the functional unit can significantly impact the LCA results and must be carefully considered. Allocation methods for multi-output systems can also complicate the LCA process. The ISO standards suggest several allocation methods, but the choice among these can sometimes be arbitrary and can significantly influence the results. The complexity and potential subjectivity of the impact assessment phase can also be challenging, as different impact assessment methods may yield different results. Lastly, regional variations, such as differences in energy mixes or waste management practices, can impact the results of an LCA. [78]

Despite these challenges, LCA remains a valuable tool for environmental decision-making. Careful planning and consistent application of the methodology can help mitigate these issues, and the limitations can be transparently communicated to ensure users of the LCA understand its context. [78]

2.6 Measurement and Calculation of Scope 3 Emissions

As earlier mentioned, Scope 3 emissions represent the entirety of an organization's indirect carbon emissions, excluding those from power generation, heat and electricity consumed, which are categorized as Scope 2 emissions. They encompass emissions from activities such as business travel, waste disposal, use of sold products, and goods procurement. This complex array of indirect emissions necessitates specific methodologies and tools for accurate measurement and calculation. [53]

Numerous methodologies facilitate the measurement of Scope 3 emissions. The most prominent among these is the Greenhouse Gas (GHG) Protocol. It offers guidelines for measuring and reporting emissions across the value chain, including Scope 3 emissions. This protocol's Corporate Value Chain (Scope 3) Accounting and Reporting Standard provides an elaborate framework for calculating and reporting Scope 3 emissions. It guides on setting boundaries, selecting appropriate emission factors, and deciding data collection methods [4]. Another widely recognized methodology is the ISO 14064-3 standard, which offers guidelines for quantifying and reporting greenhouse gas emissions and removals for organizations [55].

2.6.1 Emission Factors and Data Collection

Emission factors play an important role in calculating Scope 3 emissions. These factors represent the quantity of GHG emissions per unit of activity, enabling the conversion of activity data into emissions data. For instance, CO_2 emission intensity (expressed in gCO_2/kWh) might be a specific emission factor representing the amount of CO_2 emitted per kilowatt-hour of electricity consumed, which can be specific to each delivery country. The choice of the right emission factor is critical to achieving accurate emissions estimates and is dependent on a range of criteria, including the type of GHG, the specific process or activity, the technology used, and geographical considerations. Incorrect selection can lead to significant errors in emission estimates, thereby affecting the overall integrity and credibility of a company's reported emissions data. [4]

There are several sources of emission factors available to organizations. The IPCC publishes comprehensive Guidelines for National Greenhouse Gas Inventories, which provide a wide array of emission factors applicable to numerous sectors and activities [11]. Similarly, the United States Environmental Protection Agency (EPA) and the World Resources Institute (WRI), among others, offer repositories of emission factors specific to different industries and processes [79]. Organizations should regularly consult these sources as they continually update their databases in response to advancements in scientific understanding and technological changes.

Data collection for Scope 3 emissions can pose challenges, as it often entails obtaining information from suppliers, customers, and other stakeholders [5]. This is because Scope 3 emissions are indirect emissions that occur outside of an organization's direct control, often involving interactions with suppliers, customers, and other stakeholders. Consequently, it may be challenging to obtain accurate and complete data due to issues such as information asymmetry, confidentiality concerns, and varying data quality standards. [54]

Primary data collection involves direct communication with suppliers or conducting surveys, allowing for the acquisition of the most accurate and specific data. However, this method can be labor-intensive and may face resistance from suppliers due to concerns over sharing sensitive information. Secondary data sources, such as industry-average emission factors or publicly available databases, can serve as viable alternatives when primary data is not available or feasible to collect. These sources provide averaged data, which may not accurately represent a company's specific circumstances but can serve as a useful proxy in the absence of primary data. [6]

For a comprehensive and accurate understanding of Scope 3 emissions, companies often need to adopt a hybrid approach, integrating both primary and secondary data. This approach not only enables organizations to fill potential data gaps but also adds robustness to their emissions data by cross-validating data from different sources. Furthermore, to ensure data quality and relevance over time, companies should establish a regular data review and update process to account for changes in their operations, supply chains, and relevant emission factors. [5], [6]

2.6.2 Calculating Emissions in Scope 3 Category 1. Purchased Goods and Services

To calculate emissions in this category 1 of Scope 3 emissions, Purchased Goods and Services, the first step is the collection of data regarding the quantity of goods and services purchased. This could involve consulting procurement records or directly communicating with suppliers to acquire accurate information. Each purchased good or service then needs to be assigned an appropriate emission factor, based on its life cycle emissions from the extraction of raw materials to delivery at the company's gate. [6]

The total emissions in this category are then calculated by multiplying the quantity of each purchased good or service by its respective emission factor and summing up the emissions across all purchased goods and services. Companies should also consider the emissions from the transportation of purchased goods if these are not already included in the emission factors. [6]

Several methods exist for calculating Scope 3 emissions from purchased goods and services, each varying in their level of specificity and reliance on primary or secondary data [6]. These methods, which range from highly specific to more generic, are outlined as follows.

Supplier-Specific Method
This approach involves collecting product-level GHG inventory data directly from suppliers of goods or services. This approach offers the highest degree of specificity as it directly considers the emissions profiles of individual suppliers. [6]

Hybrid Method
As mentioned earlier, this method combines supplier-specific data and secondary data, supplementing gaps in the former with the latter. Activities under this method include gathering Scope 1 and 2 emissions data from suppliers, applying appropriate emissions factors to suppliers' activity data (e.g., materials, fuel, and electricity used, waste generated, distance transported), and leveraging secondary data where supplier-specific data is not available. [6]

Average-data Method
This method estimates emissions by considering the quantity of goods or services procured and applying relevant industry-average emission factors. While less specific than the supplier-specific or hybrid methods, the average-data method provides a valuable estimation tool when complete data is not available. [6]

Spend-Based Method
This approach considers the monetary value of goods or services purchased and applies industry-average emissions factors per monetary unit. Like the average-data method, this method offers a more generalized approach to emissions calculations. [6]

Each of these methods presents unique advantages and challenges, and the choice of method should align with the company's business goals, the nature of its supplier relationships, and the availability of reliable data. Direct data collection from suppliers, while potentially offering the most specific insights, may be resource-intensive and time-consuming. Therefore, a screening process to prioritize data collection and choose the most suitable calculation method is recommended. [6]

While more specific methodologies like the supplier-specific and hybrid methods may seem desirable, they do not automatically guarantee accuracy. In some cases, data obtained directly from suppliers could be less reliable than industry-average data. Accuracy depends on various factors, including data granularity, reliability of supplier data sources, and the allocation techniques employed. [6]

Choosing the appropriate calculation method is a strategic decision. As Figure 6 suggests, a company might employ different calculation methods for different types of data of purchased goods and services within Category 1. By employing a comprehensive mix of these methodologies, companies can ensure a more accurate and comprehensive understanding of their Scope 3 emissions from purchased goods and services. [6]

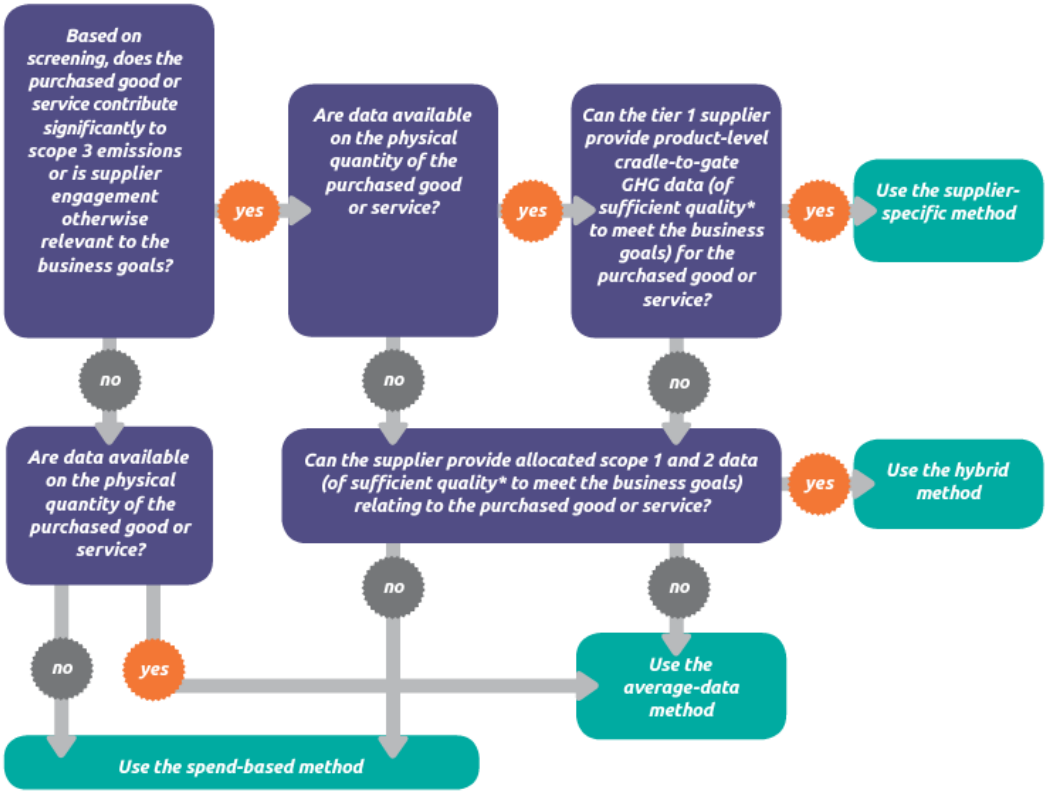

Figure 6. Flowchart outlining the process for choosing an appropriate calculation methodology for emissions from purchased goods and services [6].

2.6.3 Calculating Emissions in Scope 3 Category 11. Use of Sold Products

To calculate emissions in category 11 of Scope 3 emissions, Use of Sold Products, companies need to understand the life cycle of their products, including energy consumption during use, potential emissions during maintenance, and emissions resulting from product disposal. The data collection might involve direct communication with customers, surveys, or reviews of industry-specific studies and reports. [62]

Emission factors applicable to this category can be based on the energy consumption of the product during its use phase, the GHG emissions resulting from maintenance activities, and the emissions associated with disposal at

the end of life [7]. When using these factors, it is vital to account for variations in product use and the maintenance needs across different product types, geographic locations, and customer segments [6].

Once the emission factors are established, the total emissions for this category can be determined by multiplying the quantity of each sold product by its respective emission factor. This should also take into consideration the average lifespan of the product and the average frequency of maintenance activities. This multiplication is usually done for each product type sold by the company, and then the emissions are summed up to estimate the total emissions in this category. Given the variability in how products are used and maintained, companies should account for a certain level of uncertainty in their emissions estimates from this category. The use of ranges or scenarios can be a useful way to represent this uncertainty. [6]

For a comprehensive and accurate assessment of emissions from the use of sold products, it is important for companies to include all significant emission sources associated with the use phase of their products. This includes the emissions produced from energy consumption during use, emissions from maintenance activities, and emissions generated during the disposal or recycling of the product at its end of life. [6]

Moreover, companies should consider variability in product use patterns, conditions, and geographies. For example, a product used in a cold climate may have different emissions than the same product used in a warm climate due to differences in energy requirements. Understanding and acknowledging these variabilities can provide a more accurate and comprehensive understanding of Scope 3 emissions. [6]

Given the complexity of calculating emissions from the use of sold products, it is recommended for companies to follow established methodologies, such as the GHG Protocol's Scope 3 Calculation Guidance. This would not only ensure consistency and accuracy but also enhance the credibility of the reported emissions data. [6]

2.6.4 Challenges in Measuring Scope 3 Emissions

Measuring Scope 3 emissions presents several challenges for companies. First, data collection can be complicated, as it involves multiple stages in the value chain and requires input from various stakeholders [53]. Second, the accuracy of emission factors and the comparability of data across different sources may be limited [62]. Finally, tracking changes in the value chain over time can be challenging, as new suppliers, products, or processes may be introduced, requiring updates to the emission calculations [80].

Defining the boundaries for Scope 3 emissions is another critical challenge in measuring and calculating these emissions. Companies must establish clear boundaries for their Scope 3 emissions, ensuring that all relevant activities are included in their calculations. This involves identifying the specific sources of emissions within each of the 15 Scope 3 categories and deciding on the appropriate level of detail for the analysis. [62]

The GHG Protocol's Corporate Value Chain (Scope 3) Accounting and Reporting Standard provides guidance on setting boundaries for Scope 3 emissions, including defining organizational boundaries, operational boundaries, and the choice of consolidation approaches [4], [81]. Proper boundary setting ensures that all relevant activities are included in the calculations and helps to avoid double counting or overlooking significant emissions sources [80].

2.6.5 Best Practices for Measuring and Calculating Scope 3 Emissions

Despite the challenges, several best practices can improve the measurement and calculation of Scope 3 emissions. First, companies should establish clear boundaries for their Scope 3 emissions, ensuring that all relevant activities are included in their calculations [53]. Second, companies should prioritize data collection efforts, focusing on the most significant emission sources and working to improve data quality over time [62]. Third, companies should use consistent and transparent methodologies for calculating emissions, allowing for comparability, and tracking progress over time [80].

Engaging with suppliers, customers, and other stakeholders can also help in data collection and accuracy enhancement, as well as foster collaboration on emission reduction initiatives [82]. Regular updates to the emission calculations are crucial to account for changes in the value chain and to continually improve the understanding of emission sources. Adopting a continuous improvement approach can help companies adapt to changes in business activities and market conditions and respond to emerging regulations and stakeholder expectations [81].

2.7 Corporate Engagement in Scope 3 Emission Reduction

Corporate engagement is critical for the successful implementation of Scope 3 emission reduction initiatives, as it enables organizations to identify and address the most significant sources of indirect emissions within their value chains [80]. Effective reduction of these emissions necessitates significant corporate engagement, encompassing a range of strategies [82]. Among these, the key factors are setting definitive goals and targets, enhancing in-

ternal capacities, engaging stakeholders, ensuring transparency in reporting, and harnessing technology and innovation for emission reduction [81].

Establishing clear and ambitious goals and targets for Scope 3 emission reduction is essential for driving corporate action and commitment [83]. Organizations should develop Science Based targets aligned with global climate goals, such as the Paris Agreement, to ensure their efforts contribute to meaningful climate change mitigation [24]. By setting measurable and time-bound targets, organizations can create a sense of urgency and accountability, which facilitates the allocation of resources and prioritization of initiatives [84]. Furthermore, integrating these targets into corporate strategy and performance metrics can help ensure that emissions reduction remains a central focus of the organization [85].

2.7.1 Internal Capacity Building

Developing internal capacity to manage and reduce Scope 3 emissions is crucial for effective corporate engagement. This can be achieved through the establishment of dedicated teams and cross-functional working groups responsible for overseeing emission reduction initiatives, as well as the provision of training and resources to support employees in implementing sustainable practices. [65]

Building internal capacity not only enhances an organization's ability to identify and address Scope 3 emission sources but also fosters a culture of sustainability and continuous improvement [65]. Encouraging employee engagement and participation in sustainability efforts can also help drive innovation and generate new ideas for emissions reduction [65].

2.7.2 Stakeholder Engagement

Engagement with stakeholders, such as suppliers, customers, and investors, is vital for successful Scope 3 emission reduction efforts. By collaborating with suppliers, organizations can ensure the implementation of sustainable practices throughout their supply chain, which ensures environmental performance is prioritized and continuous improvements are made [65]. By engaging with customers, organizations can identify opportunities for product and service innovations that reduce Scope 3 emissions related to the use and end-of-life disposal [86].

By involving investors in sustainability initiatives, an increase in capital allocation towards projects that contribute to emission reduction and long-term value creation can be driven [80]. Additionally, engaging with regula-

tors and industry associations can enable organizations to shape policy and collaborate on industry-wide initiatives to address Scope 3 emissions [82].

2.7.3 Transparency and Reporting

Transparent reporting of Scope 3 emissions and reduction progress is essential for building trust and credibility among stakeholders. Organizations should adopt recognized reporting frameworks, such as the Greenhouse Gas Protocol and Global Reporting Initiative, to ensure consistency and comparability of data. [81]

Regular disclosure of Scope 3 emissions and reduction initiatives can also help organizations identify areas for improvement, benchmark their performance against industry peers, and demonstrate their commitment to addressing climate change [64]. Furthermore, third-party verification of emissions data and reduction efforts can enhance credibility and provide assurance to stakeholders [87].

2.8 Supplier Engagement in Scope 3 Emission Reduction

Suppliers hold a critical role in the complexities of Scope 3 emissions, which include both upstream and downstream activities and represent the indirect emissions generated throughout a company's value chain [81]. Gaining an understanding of the dynamics of supplier engagement can assist companies in navigating these complexities and in effectively reducing Scope 3 emissions. This engagement encapsulates various strategies and approaches, such as supplier assessment and selection, capacity building, collaboration, performance monitoring, and the utilization of digital technologies to boost communication and data sharing. [82]

2.8.1 Supplier Selection Assessment and Capacity Building

Evaluating and selecting suppliers based on their environmental performance and commitment to sustainability is critical for engaging them in Scope 3 emission reduction [88]. Environmental criteria, such as greenhouse gas emissions, energy efficiency, and waste management, can be employed to assess potential suppliers and facilitate informed decisions [89]. Prioritizing suppliers with robust environmental performance can encourage improvements in environmental practices and decrease Scope 3 emissions throughout the supply chain [90]. Moreover, integrating CSR criteria into the selection process can further incentivize suppliers to adopt sustainable practices [91].

After selecting suitable suppliers, companies must invest in strengthening their capacity to manage and reduce Scope 3 emissions. Capacity building can be achieved by providing training, resources, and technical assistance to support suppliers in adopting sustainable practices and technologies [92]. Developing guidelines and tools to help suppliers identify and prioritize emission reduction opportunities is also essential. These efforts can lead to substantial emission reductions while fostering a long-term commitment to sustainability among suppliers [93].

2.8.2 Collaboration and Monitoring

Collaboration plays an important role in driving systemic change and achieving Scope 3 emission reduction targets. Participating in multi-stakeholder initiatives, such as industry associations and sustainability networks, allows companies to share best practices, pool resources, and develop standardized approaches to supplier engagement and emission reduction [82]. This collective influence can drive improvements in environmental performance across the entire supply chain [85]. Furthermore, establishing partnerships with academic and research institutions can generate innovative solutions for emission reduction challenges [94].

Consistent monitoring of supplier performance is vital to ensure progress towards Scope 3 emission reduction targets [95]. Establishing key performance indicators (KPIs) to track supplier progress enables companies to provide feedback, recognize achievements, and identify areas requiring improvement [96]. Performance monitoring can also aid in identifying and managing environmental risks and opportunities, contributing to the long-term sustainability of the supply chain [97].

2.9 Role of Recycled Content in Reducing the Carbon Footprint of Delivered Steel

The carbon footprint of steel has become a significant global concern, particularly from Asian countries [98]. Notably, China stands out as the world's largest steel producer, having manufactured 1,018 million tons of steel in 2022 [99]. In contrast, India, the second-largest producer, produced only 154.6 million tons, according to the World Steel Association. Within this production, recycled steel is crucial, though its utilization varies among countries [99]. For example, recycled steel makes up about 25% of China's total steel output, which is below the global average of 40% [100]. This context serves as a foundation for delving into the intricate relationship between economic growth, technological innovation, and environmental sustainability in the steel sector.

While the steel industry produces over 1.8 billion tons annually, contributing to approximately 7.2% of global CO_2 emissions [101], its reliance on the traditional blast furnace method has been a major factor. This method heavily depends on carbon-intensive inputs like coke, making it a significant contributor to the industry's environmental impact [102].

Recognizing the need for change, the steel industry is gravitating towards Electric Arc Furnace (EAF) technology. This method primarily utilizes scrap steel, dramatically reducing the associated carbon footprint. Its relevance is particularly pronounced in Asian countries, where the percentage of recycled steel content differs significantly. [103]

However, as promising as recycled content appears, there are complexities across steel grades, entailing trade-offs between quality, availability, and environmental benefits. For example, the EU's proposed reduction in lead content in steel manufacturing may compromise the toughness of steel and pose potential safety risks. Leveraging recycled steel effectively requires overcoming challenges like contamination, metallurgical constraints, and ensuring the economic viability of the process. [104]

2.9.1 Emission Reduction Strategies

The challenges in the utilization of recycled steel bring new possibilities for reducing emissions. They create opportunities for advancements in diverse areas, including energy efficiency, Carbon Capture and Storage (CCS), supply chain optimization, and life cycle assessment [105]. These strategies underscore the emergence of global agreements, regulations, and incentives that have driven transformation within the industry as follows.

Energy Efficiency
Energy-efficient technologies, such as new furnace designs, heat recovery systems, and the implementation of predictive maintenance, have led to significant innovations [106]. Implementing advanced technologies can reduce energy consumption by up to 30% in some instances [106]. Furthermore, switching to renewable energy sources, such as solar and wind power, in steel production can further minimize emissions, contributing to a more sustainable energy mix [107].

Carbon Capture and Storage (CCS)
CCS holds promise on emission reduction by capturing up to 90% of CO_2 emissions, but also poses challenges. The high costs of capturing, transporting, and storing carbon, along with uncertainties regarding scalability, long-term viability, safety, and public acceptance, are considerable obstacles. Ongoing research into more cost-effective methods of carbon sequestration

is an essential aspect of future emission reduction and represents an interdisciplinary effort involving engineers, geologists, policymakers, and economists. [108]

Supply Chain Optimization and Life Cycle Analysis
A comprehensive examination of the entire supply chain, from raw material sourcing through production, transportation, utilization, and end-of-life, uncovers numerous opportunities for emission reduction. By implementing technologies that minimize waste and enhance resource utilization, companies can significantly reduce their carbon footprint. Collaborative efforts within the industry, such as sharing best practices and aligning with international standards, can lead to robust improvements. [61]

2.9.2 Comparative Analyses on Economic and Social Implications

The steel industry is closely linked to economic growth, society's demands, and caring for the environment. Strategies encouraging sustainable actions should harmonize these elements, keeping in mind both the pressing economic needs and the wider objectives of society and environmental preservation.

Comparative analyses between countries reveal a diversity of approaches to steel production and carbon emission reduction, influenced by varying resource availability, industrial capabilities, regulatory environments, and societal values. These differences show up in many ways, from the types and sources of raw materials utilized to the technologies employed in production and the regulatory frameworks that govern the industry. For instance, countries rich in iron ore and coal may still rely heavily on traditional blast furnace methods, while others with greater access to scrap steel may have more incentive to adopt EAF technology. Regulatory environments also play a critical role, with some countries having stringent environmental regulations that drive the adoption of cleaner technologies, whereas others may prioritize industrial growth and have less restrictive rules. [107], [109], [110]

Moreover, societal values and public opinion may shape government policies and corporate strategies, leading to variations in commitment to sustainability and CSR. Some countries prioritize eco-friendly practices and heavily invest in R&D, seeking to lead in the field of sustainable steel production. In contrast, others may focus on cost-effective production, which might not necessarily align with the best environmental practices. The cultural acceptance of recycled content and green technologies can differ significantly across regions, influencing both demand and supply factors. For example, in countries where there is a strong push towards sustainability,

recycled content might be more accepted and even preferred, while in others, traditional materials might still hold sway. [111]

These multifaceted variations underscore the importance of tailored strategies that align with regional and industrial contexts. There is no universal solution to sustainable steel production. Strategies must be customized to fit the unique circumstances of each country. This involves a complex interplay between technology, economics, regulations, and social factors, necessitating a nuanced understanding of each market's distinct characteristics and constraints. [111]

Moreover, long-term investments in research, infrastructure, and education are crucial in fostering innovation and sustainability within the global steel industry. Public-private partnerships can also play a crucial role in initiating the necessary technological and systemic changes. Emphasizing the importance of international collaboration, these alliances facilitate the sharing of best practices and encourage the adaptation of strategies to local conditions, driving the progression towards a more sustainable global steel industry. [112]

2.10 Green Steel Production Initiatives

The steel industry plays a crucial role in the global economy, yet its environmental footprint has become a significant concern. With approximately 7.2% of global CO_2 emissions attributable to steel production, efforts to align the industry with international sustainability goals are urgent and critical [113]. Green steel production initiatives are central to these efforts, driving transformative change that affects not only emissions but broader environmental and social dimensions.

Understanding the current landscape of green steel production requires an examination of the historical context and the inherent challenges faced by the industry. Traditional steel production processes, particularly those reliant on blast furnaces and coal, have long been associated with high energy consumption and significant greenhouse gas emissions [102]. Transitioning to sustainable practices is filled with technical, economic, and regulatory obstacles. The balance between economic competitiveness and environmental stewardship necessitates collaborative solutions that go beyond simple compliance with regulations [113].

Recent advancements in technology have paved the way for greener steel production methods. One notable example is the increased use of EAF, which can utilize scrap steel, reducing the need for raw iron ore and coal [103]. The integration of renewable energy sources into steel production

processes also offers potential to mitigate emissions. Investments in R&D in areas like hydrogen-based reduction, carbon capture, and utilization emphasize the potential for innovation in achieving sustainability in the steel production industry [107]. The most prominent green steel initiatives are detailed as follows.

Responsible Steel Initiative

The Responsible Steel Initiative (RSI) is a joint effort to standardize responsible steel production on a global scale. The RSI's standard incorporates the entire steel value chain, encompassing stages from mining to the product's end-of-life. Through the certification process, RSI closely examines the ESG aspects of steel production. This thorough examination ensures that companies are aligned with internationally recognized sustainability standards. [114]

Additionally, RSI emphasizes the importance of collaboration, promoting dialogue between companies, Non-Governmental Organizations (NGOs), industry associations, and other stakeholders. This interconnected approach enables the industry to tackle shared challenges, encouraging progress and innovation. Equally significant is RSI's commitment to transparency, ensuring public reporting on certified companies' ESG performance. By fostering trust and credibility within the industry, this transparency strengthens the resolve of the entire sector to uphold sustainability principles. [100]

World Steel Association's Sustainability Charter

The World Steel Association's Sustainability Charter is a manifestation of member companies' dedication to sustainable practices. In compliance with the Charter's 9 Sustainability Principles detailed in Figure 7, members commit to a wide range of responsibilities, encompassing environmental management, ethical conduct, stakeholder engagement, and innovative product development. [115]

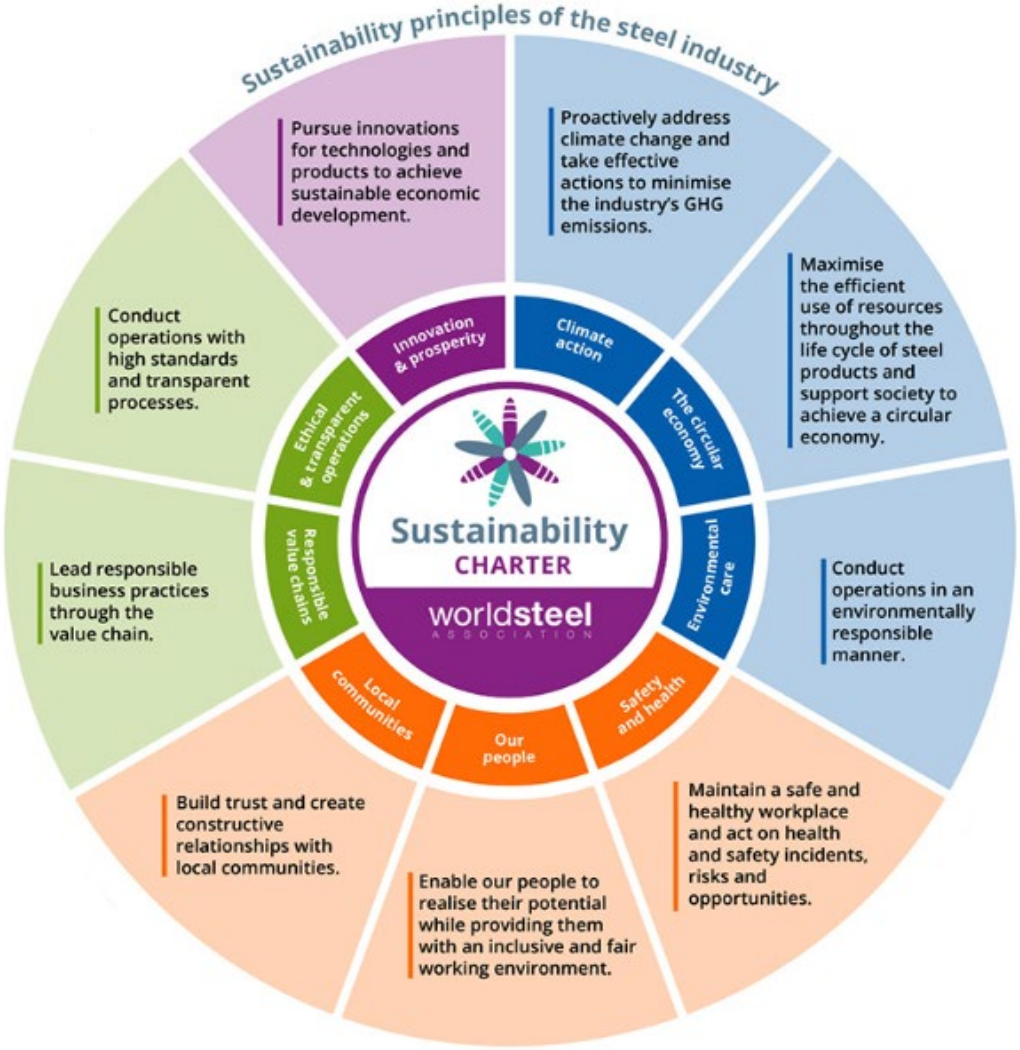

Figure 7. World Steel Association's Sustainability Principles of the Steel Industry [115].

The requirement for annual sustainability reports highlights the members' commitment, enforcing alignment with the Charter's principles and promoting transparency. The Sustainability Charter also fosters collaboration through a platform that encourages sharing best practices and benchmarking. This communal approach enhances overall efficiency and sustainability across the industry. [115]

SteelZero

SteelZero stands as a precise initiative to hasten the transformation toward a net-zero steel industry. By focusing on the demand side, it directs steel buyers and users toward a commitment to procuring 100% net-zero steel by 2050. This ambitious goal fuels the demand for green steel, acting as a catalyst for change. [116]

SteelZero's emphasis on market transformation concentrates on stimulating investment in low-carbon steel production technologies. This initiative nurtures innovation and realigns market forces to achieve net-zero targets. A holistic approach further distinguishes SteelZero, fostering collaboration across the entire steel value chain. By integrating organizations and encouraging the sharing of knowledge and best practices, SteelZero strategizes a concerted effort to reach the net-zero steel industry milestone. [116]

2.10.1 Economic and Social Implications

The shift towards sustainable steel production carries profound economic and social implications. Economically, investments in green technologies can drive significant growth in the research, development, and manufacturing sectors. This growth not only contributes to a more robust economy but can also create new job opportunities, fostering innovation and skill development within the workforce. [117]

In terms of social impact, aligning the steel industry with sustainable practices can strengthen community relations by addressing local concerns and needs. Such alignment can enhance social welfare, covering areas like health and safety. Moreover, a sustainable approach to steel production can also resonate with broader societal values, promoting a sense of responsibility towards the environment and future generations. The synergistic interplay between economic gains and social progress requires a comprehensive and thoughtful approach to sustainability. Such an approach seeks to balance profit-making with ethical considerations, ensuring that the transition to sustainable steel production is not only financially viable but also socially responsible and aligned with long-term global objectives. [118]

2.10.2 Policy and Regulatory Landscape

Government policies and regulations have significant roles in shaping green steel initiatives. Incentives for adopting cleaner technologies, emission standards, and international agreements on climate change all influence the direction and pace of transformation within the industry. The complex interplay between local, national, and international regulations underscores the importance of collaborative and coordinated policy-making efforts. [118]

Comparative analysis of these initiatives illuminates both overlapping goals and distinct strategies. Transparency, stakeholder engagement, and collaboration form a common nexus, underlying the integrated approach to sustainable development in the industry. While RSI and the World Steel Association's Charter offer expansive guidelines, SteelZero pursues more specific

avenues, emphasizing net-zero goals and technological innovation. The combination of these initiatives demonstrates a harmonized approach to forging a sustainable steel industry and affirming the global commitment to reducing carbon footprints. [117]

2.11 Carbon Border Adjustment Mechanism (CBAM)

Introduced as part of the European Green Deal, the Carbon Border Adjustment Mechanism (CBAM) aims to stop carbon leakage and the relocation of companies to countries with loose carbon rules that can weaken local climate initiatives and increase global emissions [119]. This mechanism serves as an important part of Europe's strategy to prevent such leakages [120]. As a European Commission initiative, CBAM encourages global decarbonization by imposing costs on imports based on their embedded emissions. By doing so, CBAM levels the playing field between domestic and international manufacturers. The main goal is to establish Europe's ambition of becoming the first climate-neutral continent by 2050 [120].

By imposing a carbon fee on imported goods, CBAM ensures the environmental price of carbon emissions is accounted for, regardless of the country of manufacture. Initially, CBAM will apply to imports of certain goods and select raw materials whose production is carbon-intensive and at the highest risk of carbon leakage, including cement, iron and steel, aluminium, fertilizers, electricity, and hydrogen. [119]

2.11.1 Historical Background and Methodology

The need for CBAM emerged in response to growing disparities in carbon regulation across regions. This disparity often led to unintended advantages for countries that did not enforce strict environmental regulations. The European Union’s (EU) implementation of the Emissions Trading System (ETS) in 2005 laid the groundwork for recognizing the necessity of CBAM as an extension of existing domestic measures. [121]

The concept of CBAM was partially a response to the failure of international agreements to uniformly enforce carbon reduction targets, leading to a situation where some countries could gain a competitive advantage by neglecting environmental standards. Over time, the discourse evolved to incorporate a focus on equity, considering not only the internal market competition but also the impact on less developed countries, leading to the framework proposed by the European Commission. [120]

The CBAM is designed to function in parallel with the EU Emission Trading System (ETS), imposing a price on imported goods equivalent to that which would have been paid had they been produced within the EU [121]. The mechanism considers both direct and indirect emissions, utilizing a consumption-based approach. CBAM's design also includes provisions for transparency and monitoring to ensure that the calculations are accurate and verifiable. [119]

The European Commission adopted its proposal for CBAM on the 14th of July 2021, aiming to equalize the cost of carbon emissions between domestic products and imports in selected sectors. Furthermore, the Commission adopted the regulations for CBAM's initial transitional phase on the 17th of August 2023. [119]

The transitional phase began on the 1st of October 2023, requiring companies importing selected products to report their emissions, and is set to last until the end of 2025. During this phase, these companies will not face any payment for carbon costs. Starting from 2026, importers will be obligated to purchase CBAM certificates, with the pricing aligned with the average of the closing prices on the EU's ETS from the preceding week. [119]

Different methodologies for determining the embedded carbon costs are under discussion, encompassing benchmarking and third-party verification. The ongoing discourse seeks the most equitable and effective approach. Ensuring a seamless alignment with the existing carbon pricing mechanisms in the EU is paramount. This alignment ensures the strength of the CBAM and prevents possibilities of double taxation or potential loopholes. [119]

2.11.2 Environmental, Economic, and Business Impact

Studies highlight the potential of CBAM to incentivize global decarbonization by promoting the adoption of greener technologies and methodologies outside the EU. However, some analyses also indicate potential challenges in trade relations and economic distortions. [122], [123]

Economic modelling suggests that while CBAM can lead to reductions in global emissions, its impact on international trade patterns and global economic welfare is complex and depends on the specific design and implementation. Furthermore, considerations must be given to potential impacts on developing countries, where CBAM could unintentionally create barriers to trade and development if not properly calibrated. Continued research and evaluation are required to understand and mitigate potential negative consequences. [120], [122], [123]

As the EU moves towards a sustainable future, understanding the dynamics between CBAM and free allocations is essential. Free allocations refer to emission permits that industries receive at no cost [122]. These serve a dual purpose: to shield industries from international competition and to prevent carbon leakage by ensuring they do not shift operations to regions with less stringent environmental regulations [122]. These allocations enable industries to emit a specified amount of carbon dioxide without incurring additional costs, acting as a buffer during transitional phases. [120]

The balance between CBAM-affected products with free allocations and those without has significant implications. Rapid increases in carbon and energy prices, combined with diminishing allocations, can make business cases for green investments infeasible. Without decarbonization, steel companies might face closures due to unsustainable carbon costs. Yet, a shift to alternative technologies or energy sources like renewable energy, natural gas, and hydrogen can also be challenging due to high energy costs. It becomes imperative that the CBAM's efficiency is thoroughly tested before implementing any reductions in free allocations. [120], [122], [123]

The business environment is further complicated by potential operational changes. For example, the steel sector's long-term viability requires solutions, possibly in the form of sustained free allocations for EU steel exports. Moreover, the approval of projects, sufficient funding, and access to affordable electricity, natural gas, and hydrogen become critical. Further reductions in baseline-based free allocations during the initial transition phase could endanger these industries, emphasizing the need for a balanced and phased approach. [120]

Analysis shows that CBAM significantly impacts on European businesses, especially those that import goods and materials from regions outside the European Union, like Asia [124]. For the steel sector, imported steel will be a stress test for the CBAM, presenting a challenge. As seen in Figure 8, in 2019, the EU imported 10.156 million tons of steel from Asia out of a total import of 25.3 million tons [125]. Therefore, CBAM introduces a new layer of complexity by attaching a carbon cost to these imports, representing the carbon emissions generated during their production [120].

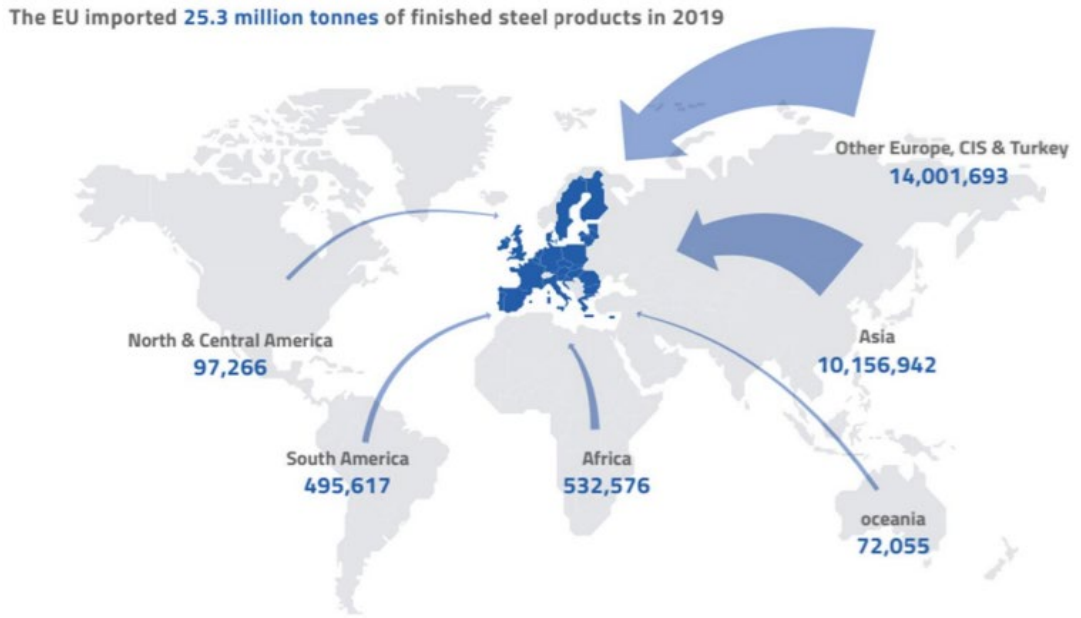

Figure 8. The amounts of finished steel products imported by the EU in 2019 [125].

The inclusion of the steel sector, either in the initial phase or in subsequent CBAM waves, should correspond with the tangible timeframe needed to devise and validate an effective regulatory framework [126]. Given the complexity and sensitivity of the steel industry, this timeline and approach are imperative. Consequently, businesses are compelled to reassess and modify their sourcing strategies, weighing both financial and environmental considerations. While some companies might gravitate towards suppliers with a smaller carbon footprint, others might struggle with compliance issues, leading to heightened operational expenses. [120]

Furthermore, the alignment of CBAM with countries outside the EU can influence market dynamics, creating potential opportunities for collaboration or, conversely, conflicting interests. The specific impact on European businesses may vary widely, depending on sectors, regulatory alignment, and market dynamics. Therefore, a nuanced understanding and strategic approach are essential to navigating these changes. [120]

2.11.3 Legal Considerations and International Response

CBAM's conformity with the World Trade Organization (WTO) rules has been a point of debate, with arguments suggesting that it must be carefully crafted to avoid being labeled as a discriminatory practice. Additionally, international responses vary, with some countries expressing concerns and others viewing it as a legitimate instrument for global climate action. [120]

The legality of CBAM under international law depends on its consistency with principles such as non-discrimination and justification under exceptions for environmental protection. Furthermore, the structure of CBAM could lead to disputes under the WTO framework, requiring careful navigation of legal precedents and international commitments. Several countries have expressed interest in adopting similar mechanisms, leading to a broader dialogue on the potential creation of a multilateral framework for CBAM. [120]

3 Research Methods

The design and methodology of this research were established to extract empirical data through comprehensive semi-structured questionnaire interviews with selected companies and Company 1's suppliers. The strategy was intended to closely examine the effectiveness of SBTs within the setting of chosen companies and Company 1's suppliers. This chapter delineates the research design, the research background, data collection methods, and the approach to data analysis and interpretation. It also underlines the various steps taken throughout the research process and their significance in obtaining reliable data and generating valuable insights.

3.1 Research Design

The research design forms the foundation for the data collection and analysis phases. The aim of this study is to conduct a thorough and well-structured investigation, thereby ensuring that the gathered evidence comprehensively addresses the initial research question.

This research strategy, implementing a qualitative approach, conducts a comparative case study of selected companies within the electrical equipment and machinery sector and Company 1's suppliers. Semi-structured questionnaire interviews and questionnaire surveys form the primary methods of data collection, complemented by an in-depth analysis of ESG reports and data from the SBTi database.

A comparative case study approach was chosen due to its capacity to support a multi-dimensional exploration of SBTs. This methodology is especially fitting for this research, considering the diverse nature of the companies under study, and the need for in-depth, qualitative data about these companies' SBT goals, actions, and corporate sustainability strategies relating to Scope 3 emission reduction.

The primary objective of this research is to inspect the emission reduction strategies of these companies, understand the challenges they face, and learn how they overcome these obstacles. Furthermore, the research scope also includes an examination of Company 1's suppliers, focusing specifically on their sustainability objectives and their alignment with Company 1's SBTs.

3.2 Research Background

To ensure confidentiality and respect the privacy of participating entities, companies in this research are referred to by numbered designations, such as "Company 1". This approach maintains the confidentiality of specific research areas and subjects associated with each entity. Furthermore, due to confidentiality considerations and the sensitive nature of certain operational details, specific numbers, precise data, and methodologies related to the procurement, production, and emission reduction processes of the participating companies have been excluded to safeguard confidentiality for public sharing.

The research started with a comprehensive series of meetings with the Company 1 Sustainability team to comprehend the current situation pertaining to Company 1's SBTs and Scope 3 emission reduction strategies. These dialogues also provided insight into the methodologies employed by Company 1 for calculating Scope 3 emissions in the most relevant categories. The study's desired outcome and scope were subsequently outlined, laying the groundwork for the data collection process.

Potential participant companies were identified by compiling a list of companies within the electrical equipment and machinery sector that had committed to the SBTi. This data was extracted from the “Companies Taking Action” file on the SBTi website [15]. The final selection of companies was based on the following criteria:

- Committed to SBTi.
- Company size comparable to or larger than Company 1 based on revenue.
- Committed to Scope 3 emission reduction goals, particularly from categories 1 and 11.
- Calculation of emissions from category 1 based on suppliers’ data.
- Similarity in emission structure.

Invitations for the research questionnaire interview were shared with 11 multinational firms from various sectors. This was based on their initial response and willingness to participate in the research. The method of contact included reaching out through general customer support emails and, when available, directly to their sustainability or environmental divisions. Additional efforts were made to identify and reach out to professionals within these companies who specialize in environmental management or related roles. This was done via professional networking sites like LinkedIn.

Despite this approach, several companies chose not to participate, citing time constraints, while others did not respond to the request. As a result, only four companies (referred as Company 2, Company 3, Company 4, and Company 5) consented to partake in the research and respond to the questionnaire. Despite the lower-than-expected response rate in the electrical equipment and machinery sector, the four participating firms provided considerable insights, showcasing a range of practices within their industry. However, due to the limited participation, a decision was made in consultation with the thesis advisor to expand the research to include other sectors.

To enrich the data on supplier sustainability engagement and emission reduction strategies related to Scope 3 Category 1: Purchased Goods and Services, we extended the questionnaire interviews to the Containers and Packaging, and Consumer Durables and Personal Products sectors. From these sectors, two major companies (referred as Company 6 and Company 7) were selected for study, as they are among the leading companies in their fields.

Company 6 participated in the questionnaire, contributing insightful data for the questionnaire. Company 7, while unable to participate in the interview due to limited availability, provided pertinent references. Therefore, the information obtained for Company 7 primarily originates from these references, enabling their inclusion in the study despite the absence of direct interaction.

In response to the low participation in the original research, the study was further broadened to explore customer expectations regarding Company 1's SBTs and Scope 3 emission reduction efforts. A selection of Company 1's customers was chosen for this analysis. The sustainability data and ESG reports for these customers were gathered primarily from online sources. This data was supplemented by an interview with the Sustainability team at Company 1, who have interacted with customers on their sustainability expectations towards Company 1.

Despite the initial participation challenges, this research was expanded to form a more inclusive and comprehensive study framework. This approach provided valuable insights into strategies for Scope 3 emission reduction.

3.3 Data Collection Methods

The data collection process plays a vital role in the study and its outcomes. The study employs both primary and secondary data to deliver a comprehensive understanding of the selected companies and their SBTs as follows.

Primary Data Collection

Primary data collection was executed through semi-structured questionnaire interviews with key personnel from the selected companies, and questionnaire surveys sent to Company 1's suppliers. These methods aimed to obtain first-hand information about the companies' strategies, challenges, and solutions for achieving their SBTs. The interviews also offered insights into the companies' perspectives on the effectiveness and reliability of the SBTi, as well as their collaboration with their suppliers.

Data collection began in February 2023 and was completed in May 2023. During this period, eight interviews were undertaken with representatives from selected companies. Due to its significant relevance to this study, Company 1 had three separate interviews. The duration of these interviews differed among companies, ranging from 30 minutes for some companies to 2 hours and 30 minutes for others. For Company 1, the three interviews lasted between 30 minutes to 4 hours and 30 minutes. Interviews conducted with various sustainability teams from different companies are referenced using a unique interview reference identification (ID). This ID has been designed to provide clear, concise, and systematic information about the source of the data, enhancing the transparency and organization of the research process. The structure of the ID follows the format [Cx.y], where 'C' stands for 'Company', 'x' denotes the company number, and 'y' represents the sequence of the interview with that specific company. For instance, [C1.1] refers to the first interview conducted with Company 1, while [C1.2] indicates the second interview with the same company. Similarly, [C2.1] corresponds to the first interview with Company 2. Further information regarding each interview is detailed in Table 1 for thorough understanding.

Table 1. Overview of conducted interviews details: Dates, Companies, Interviewees, and Interview reference IDs.

Date	Company	Interviewee	Duration	Interview reference ID
09.02.2023	Company 1	Sustainability team (2 members)	60 minutes	[C1.1]
21.02.2023	Company 1	Sustainability team (1 member)	4 hours 30 minutes	[C1.2]
01.03.2023	Company 5	Sustainability team (1 member)	2 hours 30 minutes	[C5.1]
10.03.2023	Company 4	Sustainability team (4 members)	1 hour 10 minutes	[C4.1]
14.03.2023	Company 3	Sustainability team (1 member)	1 hour 20 minutes	[C3.1]
20.03.2023	Company 2	Sustainability team (2 members)	55 minutes	[C2.1]
17.05.2023	Company 1	Sustainability team (2 members)	30 minutes	[C1.3]
17.05.2023	Company 6	Sustainability team (2 members)	30 minutes	[C6.1]

The Questionnaire to the Selected Companies in Electrical Equipment and Machinery Sector

The questionnaire interview was designed to cover a broad range of topics that aligned with the research objectives. Employing a mix of closed-ended and open-ended questions, it provided respondents the opportunity to offer detailed insights into their strategies, challenges, monitoring mechanisms, and supplier interactions concerning the implementation and achievement of SBTs. This comprehensive data collection approach facilitated an in-depth analysis, leading to informed conclusions and recommendations on companies' SBT performances and their impact on Company 1's business development and sustainability goals. The questions can be found in Appendix A.

The Questionnaire to the Selected Companies in The Containers and Packaging Sector and in The Consumer Durables and Personal Products Sector

In the sector-specific questionnaire directed towards Company 7 within the Containers and Packaging industry, and Company 6 in the Consumer Durables and Personal Products sector, a similar structure of inquiries was maintained to align with the central research goals. Respondents were en-

couraged to elaborate on their SBT-related strategies, challenges, monitoring processes, and supplier relationships. The intention of this tailored line of questioning was to facilitate a comprehensive understanding of each company's SBT performance, allowing for insightful conclusions and recommendations that could be relevant to Company 1's sustainability and business growth. The set of questions is presented in Appendix B.

The Questionnaire Survey to the Company 1's Suppliers

Additionally, a detailed questionnaire survey was dispatched to Company 1's suppliers. The goal of the survey was to delve deeper into suppliers' sustainability strategies, specifically their GHG emissions and the implementation of SBTs. This survey enriched the research by providing insights into suppliers' perspectives and challenges in achieving their SBTs. Importantly, this process also contributed to the integration of these strategies into Company 1's sustainability initiatives, thereby enhancing their efficacy.

Secondary Data Collection

Secondary data for this study was sourced from the analysis of the SBTi database and ESG reports from selected companies and Company 1's suppliers. This data complemented the insights gathered from the primary data collection process. These sources offered real-time perspectives into the sustainability strategies, objectives, and progress of the respective companies. The empirical data collection process was also enhanced by insights derived from project meetings and public documents. Alongside this, a comprehensive review of essential literature and research was undertaken concurrently to identify knowledge gaps and establish the necessary theoretical frameworks for this thesis.

These data sources provided real-time insights into the sustainability strategies, objectives, and progress of the respective companies. This form of data served to enhance the insights obtained from the primary data collection process.

4 Research Data Analysis

This chapter initiates with an in-depth exploration of primary data, derived from meetings with Company 1's Sustainability team members and a review of Company 1's existing SBTs and Scope 3 emission reduction strategies. The next stage of analysis includes insights procured from semi-structured questionnaire interviews conducted with selected companies, including those from the electrical equipment and machinery sector, and those extended to the Containers and Packaging, and Consumer Durables and Personal Products sectors. Additionally, surveys were carried out with Company 1 suppliers, which provided nuanced understanding of their SBT strategies, challenges, and solutions in relation to Company 1's corporate sustainability initiatives. Secondary data, obtained from the SBTi database and ESG reports, were further assessed to illustrate the sustainability strategies, objectives, and advancements of these corporations, including Company 1's customers. This thorough examination forms the empirical foundation for the ensuing discussion and conclusions of the study.

4.1 Company 1's SBTs

Company 1 is committed to mitigating its environmental impact through the intensive implementation of SBTs, which are integral to the company's corporate sustainability policies. These targets not only align with the Paris Agreement but also reflect Company 1's strategic decisions across various business dimensions, including supplier selection and product design.

Company 1 has made a strong climate pledge with firm targets. Starting from a 2018 baseline, Company 1 has committed to reducing its GHG emissions by 50% by 2030, with a focus on Scope 1 and 2 emissions and a 40% reduction in Scope 3 emissions over the same target period, relative to orders received. The company's ambitious climate targets include achieving carbon-neutral operations by 2030 [9]. This commitment symbolizes the company's forward-thinking approach to environmental sustainability. Additionally, the company perceives the complexities surrounding Scope 3 emissions and is dedicated to establishing groundbreaking SBTs to address them.

Recent sustainability reports suggest that the company is on track, showing commendable progress in realizing its SBTs. The company's dedication to adopting energy-efficient methods and prioritizing green energy sources has led to substantial reductions in their carbon emissions since a prior benchmark year. Strategically, they are setting their sights on amplifying

renewable energy utilization in the imminent years, showing a marked progression from earlier benchmarks.

Understanding that its supply chain GHG emissions form a substantial portion of its total emissions, Company 1 has been actively engaging suppliers to reduce their carbon footprint. This comprehensive approach, supported by data from supplier surveys, has proven instrumental in Company 1's efforts to minimize Scope 3 emissions. [9]

Despite challenges in its sustainability goals, Company 1 remains determined in its objectives. Company 1 aims to reduce emissions from different parts in the upcoming years, lessen the carbon footprint of its current equipment over the next decade. These strategic initiatives, influenced by their SBTs, underscore Company 1's determination to actively contribute to the global climate agenda. By setting ambitious targets and implementing a comprehensive range of strategic initiatives, Company 1 has emerged as a notable example in the implementation of SBTs to its corporate sustainability policies.

4.2 Company 1's Strategies for Scope 3 Emission Reduction

Company 1's strategies for addressing Scope 3 emissions revolve around three main pillars, which are supplier engagement, product and service design, and customer collaboration [C1.1]:

Supplier Engagement
Company 1 is working towards a stable supplier network that values responsible and sustainable business practices. This means fostering a collective commitment to reducing environmental impact, including carbon footprint reduction. To achieve this, Company 1 actively communicates with its suppliers through various platforms, including trade fairs and annual supplier days, aiming to foster collaboration and knowledge sharing. Central to this effort is Company 1's sustainability program, which encourages suppliers to actively measure, report, and reduce their GHG emissions [9]. This program is supported by a series of supplier assessments, including audits and an annual excellence certification program, which evaluates suppliers on environmental practices, compliance, and quality parameters, fostering a continuous dialogue on day-to-day operations [9]. This approach, which includes regular check-ins on environmental practices and ethics, is designed to encourage cooperation and shared responsibility. Moreover, Company 1 assists suppliers in improving their CO_2 reporting skills, aiming to amplify the positive effects of its sustainability policies through synergis-

tic supplier relationships, nurturing a unified approach to environmental sustainability and responsible business practices [C1.1].

Product and Service Design
Company 1 also directs substantial effort towards minimizing the environmental impact of its offerings throughout their life cycle. The company has developed several energy-efficient solutions, which can significantly reduce energy consumption compared to traditional technology [9]. Company 1's commitment to sustainable product and service design extends to its manufacturing processes, where it adopts environmentally friendly materials and processes to reduce emissions associated with raw material extraction, processing, and transportation. Furthermore, Company 1 has integrated circular economy principles into its operations, advocating for product life extension, and recycling to minimize waste and further decrease Scope 3 emissions. [C1.2]

Customer Collaboration
Recognizing the role customers play in sustainability, Company 1 fosters customer collaboration to facilitate the adoption of energy-efficient and low-emission solutions. The company equips customers with tools and services to help them optimize building performance and reduce energy consumption. By empowering customers with the necessary information and support, Company 1 facilitates informed decision-making about their buildings' environmental impact and fosters shared commitment towards emission reduction efforts. Company 1's active participation in industry initiatives and policy engagement further illustrates its commitment to driving change beyond its immediate operations. [C1.3]

4.3 Challenges and Opportunities in Scope 3 Emission Reduction

Despite Company 1's proactive approach to Scope 3 emission reduction, challenges persist. These include data challenges, such as obtaining reliable and comprehensive emissions data from suppliers, methodological challenges in calculating and verifying Scope 3 emissions, boundary challenges related to defining the scope of responsibility for emissions, and organizational challenges, such as coordinating and integrating sustainability efforts across various functions and teams within the company. [C1.2]

However, the company views these challenges as opportunities for continuous improvement and innovation. They push Company 1 to refine its strategies, collaborate with other industry players, and develop innovative solutions to overcome obstacles and further reduce emissions. Company 1's journey thus offers valuable insights into the intricacies of adopting and

implementing SBTs and the strategies to surmount the challenges involved in Scope 3 emission reduction. [C1.2]

4.4 Company 1's Approach to Calculating Scope 3 Emissions

Company 1 places a significant focus on the calculation and reporting of Scope 3 emissions across various categories. The calculation of these indirect emissions, generated in the company's value chain, is a critical component of Company 1's environmental management strategy.

Company 1 has devised comprehensive methodologies to calculate these complex indirect emissions, going beyond compliance with regulatory requirements to fully understand and control its emissions. This dedication to environmental management is reflected in the detailed calculation and comprehensive reporting of these emissions. Using these insights, the management can make informed decisions about further emission reduction strategies, leading to more efficient operations and cost savings. [C1.2]

To calculate Scope 3 emissions, Company 1 employs a methodological approach that aligns with the standards set out in the GHG Protocol. As mentioned earlier in Chapter 2.4.1, the GHG Protocol identifies 15 Scope 3 emission categories. Company 1 addresses all of these categories, compiling a comprehensive Scope 3 inventory that underscores the areas with the most significant emissions and where reductions are most achievable. This approach optimizes the impact of Company 1's reduction efforts, resulting in significant emission reductions. The most notable categories are as follows. [C1.1]

Category 1. Purchased Goods and Services
Addressing the emissions from Category 1 is a crucial focus area for Company 1, as it represents a significant portion of their overall environmental impact. In response, Company 1 is actively working to reduce these emissions by engaging with suppliers to enhance their sustainability practices, implementing detailed criteria for sourcing environmentally friendly goods and services, and seeking alternatives that have a lower carbon footprint [C1.2]. According to Company 1's Sustainability Report, emissions deriving from purchased goods and services comprise a substantial one-third of Company 1's indirect emissions. [9]

Category 11. Use of Sold Products
Recognizing the significant contribution of Category 11 to its total emissions, Company 1 strives to reduce these emissions by improving the energy efficiency of its products, providing customers with clear guidelines for

product use, and encouraging sustainable practices. According to Company 1's Sustainability Report, emissions deriving from products' lifetime energy consumption comprise a substantial two-third of Company 1's indirect emissions, highlighting their biggest significant impact on the company's overall environmental footprint. [9]

For addressing these notable Scope 3 emission categories, Company 1 has also been proactive in leveraging digital tools and data analytics, which is evidence of their readiness to adapt and innovate. These technologies have significantly enhanced Company 1's emissions tracking and reporting capabilities, producing more accurate and timely data. This commitment not only displays the company's dedication to sustainability but also its willingness to employ the latest technology for effective emissions management. [C1.1]

Overall, these measures signify an important step in Company 1's future sustainability performance development. They demonstrate that the company is not merely focused on achieving its sustainability targets. Company 1 is also dedicated to adapting, innovating, and leveraging the latest technology to accomplish these goals. [C1.1]

4.5 Strategies and Challenges in Reducing Scope 3 Emissions in the Electrical Equipment and Machinery Sector

Understanding and managing Scope 3 emissions in the electrical equipment and machinery sector requires a deep exploration of the sector's unique characteristics and challenges. Companies in this sector manufacture a broad range of products, from small appliances to large industrial machines, each of which is composed of various components and materials. This complexity significantly influences the strategies for reducing Scope 3 emissions.

4.5.1 Sustainable Procurement Practices

In the electrical equipment and machinery sector, sustainable procurement carries substantial weight concerning Scope 3 emissions. The globalized nature of this sector means that it has elaborate supply chains, each link contributing to the product's emissions. The integration of environmental criteria into procurement processes is one way to manage these emissions, thereby fostering suppliers to adopt sustainable practices. Such green procurement practices can reduce emissions significantly throughout the supply chain.

Sustainable procurement demands an intricate understanding of the suppliers' capabilities, their environmental performances, and in some cases, even their readiness to adopt such measures. For this reason, companies may need to dedicate resources for supplier training and education, audits, and continuous engagement to ensure these practices' effectiveness. In the context of the electrical equipment and machinery sector, these practices also require a deep understanding of the environmental impact of different materials and components used in electrical products.

4.5.2 Product Life Cycle Assessment and Circular Economy Strategies

When considering electrical products and machinery, the life cycle perspective is crucial. The environmental impact extends far beyond the manufacturing phase and covers aspects like energy consumption during use, end-of-life disposal, and even sourcing of raw materials. An all-encompassing life cycle assessment can unveil opportunities for emission reductions hitherto undiscovered. However, the implementation of life cycle management strategies demands intricate knowledge spanning multiple fields. This includes proficiency in energy-efficient design, manufacturing processes, and end-of-life management.

The principles of the circular economy can be transformative for the electrical equipment and machinery sector. Given the high value and environmental impact of the materials used in electrical products, strategies promoting reuse, refurbishment, and recycling can have profound environmental and economic benefits. For instance, companies could implement take-back programs for used products, providing them with a source of valuable materials while reducing waste and the associated emissions. However, the implementation of such a strategy requires an efficient reverse logistics system, which can be a challenge. It also requires appropriate facilities for the recycling of used products.

4.5.3 Customer Engagement and Integration of Renewable Energy and Energy Efficiency Measures

Customer engagement is an important strategy when looking to reduce Scope 3 emissions in the sector under consideration. Electrical appliances and machinery have specific operating conditions for optimal energy efficiency, and customers may be uninformed about these. By providing clear instructions and tools, customers can optimize product usage, thereby significantly reducing emissions during the use phase. Further, companies can offer recycling programs and information about proper disposal methods to minimize emissions associated with product disposal. These efforts necessi-

tate a proactive approach to customer engagement and education, a task that can be resource-intensive but has the potential to make a significant impact on the reduction of Scope 3 emissions.

Renewable energy and energy efficiency measures can significantly impact reducing Scope 3 emissions in the electrical equipment and machinery sector. Companies can choose to power their manufacturing facilities with renewable energy, leading to considerable emissions reduction. They can also design products to consume less energy during operation, reducing downstream emissions. Further, companies can encourage their suppliers to adopt renewable energy, helping to reduce upstream emissions.

4.5.4 Collaboration with Industry Associations and Partnerships

Active collaboration with industry associations can lead to innovative solutions for emission reductions. The electrical equipment and machinery sector is marked by constant technological innovation and high competition. Industry collaborations can help set common sustainability goals, align emission reduction strategies, and encourage the adoption of best practices. By participating in such initiatives, companies can influence the development of industry-wide sustainability standards, leading to collective progress towards climate goals. Such collaborations can also facilitate access to advanced tools and practices to assess and manage emissions. However, the effectiveness of such collaborations often depends on a shared vision and a commitment to sustainability among all stakeholders.

4.6 Analysis of Questionnaire Interview Results in the Electrical Equipment and Machinery Sector

The questionnaire interview results in the electrical equipment and machinery sector originate from five distinct interviews conducted with industry-leading companies. These entities shared their unique strategies to reduce Scope 3 emissions, providing a rich and invaluable perspective. In the presented analysis, these strategies are situated within a broader ecological and socio-economic framework. This comprehensive approach illuminates the way these companies' strategies interplay with overarching global environmental challenges, including climate change and biodiversity preservation.

4.6.1 Methodological Approaches to Scope 3 Emissions Reduction

In examining the corporate approach to Scope 3 emissions reduction, it was apparent that each company employed a distinct methodology, offering in-

sights into the nuances of emissions management. Company 1's meticulous and multi-layered approach to emissions computation stood out for its commitment to ISO standards, reflecting a comprehensive strategy that recognized the interconnected nature of corporate operations and their collective contribution to emissions.

Company 2, Company 5, and Company 4 illustrated the continuous evolution and learning curve intrinsic to emissions reduction strategies, underscored by their ongoing refinement of Scope 3 emissions calculation methodologies. This highlights the dynamism required in corporate responses to the ever-evolving body of knowledge surrounding climate change and its impacts. [C2.1], [C5.1], [C4.1]

Company 3 demonstrated a transformative strategy marked by innovation, focusing on the development of electrified systems to replace diesel products. This willingness to challenge traditional operational norms and venture into new technological territories was a clear illustration of the mindset required to combat environmental challenges. [127], [C3.1]

The relationship between R&D and Scope 3 emissions is crucial, as demonstrated by Company 2, suggesting an intricate feedback loop where emissions reduction strategies inspire R&D efforts, and the subsequent outcomes of R&D further enhance emissions reduction [128], [C2.1]. Company 5's strategy of allocating an R&D budget to the development of more sustainable products underscores the role of dedicated resources and innovative research in driving a strategic shift towards sustainable operations [C5.1].

4.6.2 Scope 3 Emission Calculations: Category 1 and 11

Scope 3 emission calculations, particularly Category 1 and Category 11 require detailed and thorough evaluation processes. The case of Company 1 is particularly enlightening. Company 1 employs a multi-layered approach, combining data from various sources and strictly following the ISO standards. These ISO standards set benchmarks for the energy consumption and efficiency of its products, showcasing Company 1's commitment to reliable measurement tools. [C1.1]

Such a detailed approach underscores the necessity for thoroughness and adherence to exacting standards. Accurate calculation is a foundational step in the emission reduction process. Without it, efforts to curb emissions could be misguided or inefficient. In this context, Company 1's strategy becomes an exemplar for other companies in the sector.

Category 11 emissions often represent a substantial part of a company's total carbon footprint. Therefore, it requires an equally careful evaluation. An interesting example of this is Company 4, which has broadened its Scope 3 emissions calculation to include emissions from company used cars [129]. By considering a more comprehensive scope of indirect emissions, Company 4 acknowledges that emission sources are multifaceted and interconnected. [C4.1]

The contrast between Company 1's methodical compliance with international standards and Company 4's expansive view of emission sources offer valuable insights. These examples underscore the multiplicity of viable strategies to assess and tackle Scope 3 emissions. It also highlights the crucial role that industry context and company-specific factors play in shaping these strategies. [C1.2], [C4.1]

It is crucial to consider these insights in the broader picture of the corporate world's contribution to climate change mitigation efforts. These strategies, when disseminated and adapted across industries, have the potential to create significant changes at the macro level.

4.6.3 Supplier Assessment and Cooperation Related to Scope 3 Emissions

Supplier assessment and cooperation is an integral part of managing Scope 3 emissions. Understanding the carbon footprint of the supply chain offers insight into potential areas for emission reduction. Collaborating with suppliers can also facilitate the adoption of better practices, leading to overall emission reduction.

Company 1 and Company 2, for instance, actively engage with their suppliers to ensure they meet the company’s sustainability standards. They assess their suppliers not just on cost, quality, and delivery reliability, but also on environmental and other sustainability factors. This comprehensive assessment facilitates a significant reduction in Scope 3 emissions. It underlines the necessity of cooperation and shared responsibility within the supply chain in mitigating environmental impacts. [C1.2], [C2.1]

Third-party audits are a key component of the company’s emissions reduction strategies, emphasizing the importance of independent verification in Scope 3 emissions reporting. The use of different auditors brings a range of standards, methodologies, and expertise to the fore, adding depth and diversity to the emissions calculation and verification process.

4.6.4 Supplier Commitment to SBT and Alternative Sustainability Measures

Company 4 provided a unique perspective on supplier engagement in climate initiatives. Their strategy involved consistent outreach and training programs for subcontractors, particularly those with substantial purchasing volumes and long-term working relationships. Company 4's efforts spanned a range of activities, from providing concrete examples and training on CO_2 reduction to interpreting the complex interplay between handprint, footprint, and Scope 1, 2, 3 terminologies. [129], [C4.1]

To verify subcontractors' actions and ensure the effectiveness of Company 4's training programs, the company employs regular internal and external sustainability audits. These audits also allowed Company 4 to continuously assess their suppliers' commitment to the SBTi, furnishing them with annual reports and guidance as necessary [129]. Notably, Company 4 recognized the voluntary nature of the SBT program and respected its suppliers' autonomy in committing to sustainable practices [C4.1].

Company 4 further highlighted the importance of supplier commitment to SBT. While advocating for the relevance of SBT as the ideal commitment for all suppliers, they acknowledged the practical challenges and potential infeasibility of SBT for some suppliers, especially those in countries not part of the Paris Agreement [129]. In such instances, Company 4 accepted alternative methods of commitment, such as verified sustainability reports or annual reports, providing flexibility for its suppliers [C4.1].

Moreover, Company 4 has set an ambitious goal, that 30% of its direct suppliers, based on spend for purchased goods and services, will adopt Science Based targets by 2025. Current data from Company 4 reveals strong progress towards this commitment. Nearly 2,000 of its suppliers are already listed in the SBT database, representing approximately one-fifth of their current supplier count [C4.1]. This figure includes parent and subsidiary companies that have joined the SBT program, indicating a significant alignment with the SBT initiative. This serves as evidence of the effectiveness of Company 4's supplier engagement strategy, which could be beneficial for other companies in the same sector, including Company 1.

4.6.5 The Green Steel Initiative and Recycled Content Level in Steel

The rise of sustainability and environmental protection as key drivers in business decision-making is reshaping how companies operate across all functions. As such, green steel initiatives and the recycled content level in steel production are emerging as significant considerations in the electrical

equipment and machinery sector, as exemplified by Company 5 approach to sustainability. [130], [C5.1]

Balancing sustainability efforts with other crucial aspects of business, like safety and cost, is a critical challenge in this field. An example of this delicate balance is the proposed reduction in lead content in steel manufacturing, an initiative introduced by the European Union to reduce its poisonous impact. However, a decrease in lead can compromise the toughness of the steel, posing potential safety risks. Such complexities underline the intricacy of sustainability efforts and the need for comprehensive solutions. [C5.1]

Engagement in collaborative efforts, such as Company 5's planned participation in global workshops focused on decarbonization, highlights the importance of collective action. These collaborative initiatives aim to encourage steel suppliers to adopt green steel practices and commit to the SBTi, paving the way for industry-wide decarbonization. [C5.1].

However, obtaining reliable data for modeling and calculating the recycle content level and green steel goals remains a significant challenge. The difficulty of data gathering impedes the accurate assessment and tracking of progress in these areas. According to the WWF's Steel Sector Decarbonization workshop group, it is worth noting that increasing the recycled content in steel alone is insufficient to adequately reduce emissions. This underscores the need for a multifaceted approach to decarbonization that includes promoting green steel, committing to the SBTi, and reducing steel usage in general. [126]

By highlighting the challenges and efforts related to green steel initiatives and recycled content levels in steel, this chapter contributes to the broader understanding of sustainability in the electrical equipment and machinery sector. It also emphasizes the potential of collective action and the integration of sustainability across all business functions in achieving the necessary environmental targets. The insights shared by companies like Company 5 serve as a valuable guide for other businesses navigating the complexities of sustainability in their operations.

4.6.6 CBAM in Supplier Cooperation

Company 3 highlighted the emerging role of the CBAM in its cooperation with steel suppliers to reduce CO_2 emissions. As mentioned in Chapter 2.11.1, the European Commission adopted its proposal for CBAM in July 2021, aiming to prevent carbon leakage by imposing carbon costs on certain imported goods. This mechanism incentivizes cleaner production and directly impacts companies importing high-emission steel by requiring CBAM

certificates starting from 2026, which could potentially increase costs. [C3.1]

Company 3 emphasized that CBAM is expected to drive a shift towards greener metal supply in the near future, signifying a progressive change in the business landscape influenced by regulatory mechanisms. This insightful perspective on CBAM deepens our understanding of how policy mechanisms can profoundly affect corporate strategies geared towards sustainability and carbon reduction. Company 3 also pointed out that CBAM will have a significant effect on companies' steel importation, material costs, and other supplier policies. Particularly notable is the transitional phase, which began on the 1st of October 2023, where companies importing selected products will be mandated to report their emissions. By 2026, importers will be obligated to purchase CBAM certificates. [C3.1]

This analysis of Company 4's and Company 3's responses to supplier engagement and the CBAM provide further insight into the complexities of managing Scope 3 emissions. It underscores the importance of continuous supplier engagement, flexible commitment mechanisms, and the influence of regulatory policies in the pursuit of carbon reduction and sustainable operations. [C4.1], [C3.1]

4.6.7 Data Collection and Reporting

Data collection and reporting form the cornerstone of transparency and accountability in emissions reduction. One exemplar of this is Company 5, which dedicates substantial resources to data collection and in-depth analysis, substantiated by detailed emissions data in its annual sustainability reports [C5.1]. This practice not only aids in setting accurate reduction targets and monitoring progress but also fosters trust among stakeholders through heightened transparency. A robust data management system reflects the company's commitment to creating a low-carbon economy.

In this area, Company 2's approach to data verification is noteworthy. By inviting third-party audits, Company 2 not only validates its reported emissions data but also enhances the credibility of its sustainability efforts. This practice is consistent with the principles of materiality and reliability, which are key elements of sustainability reporting according to the GRI. The use of various auditors also introduces a range of standards and methodologies, which enriches the quality of the data collected and reported. [C2.1]

4.6.8 Aligning with Sustainability Goals

The analysis of questionnaire interview data between interviewed companies offers insights into common practices, challenges, and the emphasis these companies place on sustainability. By examining the data, current trends and strategies in the sector's sustainability alignment can be highlighted as follows.

Transparency through EPDs and Carbon Offsetting
Transparency in emissions reporting, as seen through the companies' approaches to the EPD process, is another common theme. The varying levels of maturity in these processes underscore the ongoing journey towards comprehensive disclosure and transparency in emissions reporting.

The domain of carbon offsetting introduces another dimension to the strategies of companies. While some leverage carbon offsetting to achieve carbon neutrality, particularly in business travel operations, they view it as a secondary emissions reduction mechanism, to be used when other mechanisms are not feasible. This disparity reflects the ongoing discourse on the role of carbon offsetting within the larger framework of sustainability. [C1.2]

The Role of Sustainability Certifications
In examining the role of sustainability certifications, Company 2's strategy illustrates the potential for aligning corporate product offerings with broader sustainability benchmarks in the construction industry. This alignment of internal strategy with external sustainability goals serves as an example of how companies can leverage their products and services to contribute to the larger sustainability agenda. [C2.1]

Customer Expectations Driving Sustainable Solutions
Customer expectations play a significant role in shaping corporate approaches to emissions reduction. The growing demand for sustainable solutions, reflected in Company 1's strategic incorporation of sustainability into its operations, underscores the influence of market forces in driving corporate environmental strategy. [C1.3]

Emissions Accounting for Office Buildings and Vehicle Fleet
Companies' approaches to accounting for emissions from office buildings and vehicle fleets highlight the diversity in their emission reduction strategies. Company 4's inclusion of car emissions under Scope 3, for instance, implies a more comprehensive interpretation of indirect emissions [C4.1]. This approach aligns with the GHG Protocol's broad view of Scope 3 emis-

sions, reinforcing the importance of a holistic emissions accounting framework.

4.6.9 Linking Corporate Strategy with Broader Environmental Context

By situating these findings within a broader environmental and socio-economic context, this analysis underscores the interconnectedness of corporate strategies and wider environmental trends. The strategies adopted by these companies have significant implications for climate change and biodiversity loss, thus contributing to the global response to these pressing issues.

For example, Company 1's thorough Scope 3 emissions calculation methodology, coupled with its carbon offsetting initiatives, reflect a profound commitment to climate action [C1.2]. Company 2's dedication to R&D and its alignment with sustainability certifications demonstrate its integration with global sustainability benchmarks [C2.1]. Meanwhile, Company 5 and Company 3's ongoing development of environmental procedures underscore the urgent need for increased research and industry-wide focus on the impacts of industrial operations on climate change [C5.1], [C3.1]. Company 4's inclusive approach to Scope 3 emissions calculation indicates a commitment to reducing the environmental footprint of its operations [C4.1].

These examples underscore the multifaceted strategies employed by companies within the electrical equipment and machinery sector to address their environmental impacts. The diversity in their approach, ranging from meticulous data collection and reporting to innovative carbon offsetting and comprehensive emissions accounting, reflects the complexity of sustainable development. It stands as a testament to the myriad ways in which companies are actively contributing to the broader sustainability agenda and advancing efforts to mitigate climate change.

4.7 Containers and Packaging & Consumer Durables and Personal Products Sectors: Questionnaire Interview Results

To deepen understanding of supplier engagement and varied strategies for SBTs and Scope 3 emission calculations, research was conducted on the practices and results of two prominent companies, Company 6 and Company 7. The investigation examined their approaches to sustainability, SBTs, and Scope 3 emission reduction within their respective sectors. The ultimate objective is to extrapolate potential lessons and strategies that could be relevant to other industries, such as the electrical equipment and ma-

chinery sector represented by Company 1. The containers and packaging sector has seen a significant shift towards sustainability in recent years, propelled by changing consumer behaviors and regulatory pressures. Company 6 and Company 7 have formulated unique strategies to address these challenges.

4.7.1 Company 6: Approach and Results

Company 6 has demonstrated a firm commitment to environmental sustainability. The packaging decisions for these products are significantly influenced by an increasing consumer focus on health, wellness, hygiene, and sustainability. Company 6's strategic approach underscores its efforts to minimize its ecological impact and align its practices with the evolving consumer expectations and regulatory shifts. [131]

Company 6's proactive approach is manifested in its adherence to the SBTi. This alignment with scientifically supported climate goals, rather than being a driver for drastic changes in the company's operations, serves to influence decisions within Company 6's value chain. This approach is fitting for a company like Company 6 that has a relatively low energy-intensive nature. [131], [C6.1]

The management of GHG emissions is central to Company 6's sustainability strategy, with particular emphasis placed on Scope 3 emissions. A significant development in this regard is the adoption of a material flow analysis. This procurement-focused data approach complements the LCA currently in use by Company 6. With an extensive LCA database covering several thousand product LCAs, Company 6 is equipped with an effective tool for the accurate measurement and management of its carbon emissions. [131], [C6.1]

Working closely with suppliers forms a crucial part of Company 6's approach. The company launched an initiative which invites suppliers to commit to reducing emissions significantly by a target year. Starting with a group of suppliers, this initiative is projected to expand to a larger number, representing a major portion of Company 6's upstream Scope 3 emissions, within a few years. [C6.1]

Furthermore, Company 6 addresses the challenges surrounding data collection and transparency by participating in collaborative industry efforts addressing the issue, thus improving carbon transparency across the supply chain. Company 6’s own action plan for climate transition also indicates the company's approach to carbon credits, aiming to balance residual emissions with carbon removals, opting not to purchase carbon credits. [C6.1]

Company 6's commitment extends to product development, with a focus on reducing plastic usage in packaging and promoting refillable solutions. They also prioritize alternative formulations, deforestation-free supply chains, lower carbon cleaning and laundry products, and plant-based alternatives. The company's investment in biotechnology research, logistics, and transport emissions reduction, and the transition to greener fuels and transportation methods all underline their commitment to sustainability. [131], [C6.1]

Company 6 is committed to achieving significant reductions in emissions from company-owned sources and those generated by purchased electricity, heat, and steam within the next few years. These sustainability efforts are demonstrated through Company 6's adherence to globally recognized standards and principles. Through these strategies and commitments, Company 6 continues its journey towards net-zero emissions, standing at the forefront of sustainable business practices and catering to the diverse sustainability expectations of its consumers. [131], [C6.1]

4.7.2 Company 7: Approach and Results

Company 7 has made sustainability a core business objective. The company's mission is not only to provide safe, innovative, and environmentally sound products but also to contribute to a low-carbon circular economy. This commitment is reflected in their consistent efforts to measure, manage, and reduce their carbon footprint across all stages of their operations. Signifying their commitment to sustainability, Company 7 joined the SBTi and had their climate impact reduction targets approved in 2017 [132]. This marked them as the first company in the specific industry to accomplish this, thereby solidifying their industry leadership in sustainable practices.

Company 7's dedication to sustainability is reinforced by its data-centric approach. They conduct comprehensive LCA studies, which provide valuable insights into the environmental impact of their products. The studies indicate that Company 7's cartons, particularly those using bio-based polymers, have a lower carbon footprint compared to alternative packaging materials. [132]

Company 7's environmental strategy spans across Scope 1, Scope 2, and Scope 3 emissions, accounting for fuel consumption, electricity usage, transportation, and waste management, among other factors. This comprehensive approach enables them to quantify emissions at every stage of their value chain, including their operations, suppliers, customers, and end-of-life disposal scenarios for their products. Building upon this, Company 7 publishes an annual sustainability report, adhering to the GRI Sustainabil-

ity Reporting Standards. They report their GHG emissions inventory data annually to the CDP and use this data to track their progress towards their SBTs. They also prioritize SBTs and climate change prevention in their business development, aiming for net-zero emissions by 2050. [132]

The company's approach includes responsible sourcing, the use of renewable materials, ensuring recyclable packaging, and minimizing the carbon impact of their packages throughout their life cycle. They aim to achieve net-zero GHG emissions in their operations by 2030 and across the value chain by 2050, integrating sustainable practices across procurement, manufacturing, distribution, and end-of-life management. [132]

For measuring and calculating emissions, Company 7 uses the GHG Protocol, including the GHG Protocol Scope 3 Standard, to calculate and measure CO_2 emissions for Category 1: Purchased goods and services. The calculation includes data from suppliers or industry averages and may involve assumptions or estimations due to data variability. The company also collaborates with its suppliers to reduce CO_2 emissions. They have initiated a program involving the majority of their base material suppliers, representing 90% of their purchased materials, to accelerate their sustainability transformations, including the reduction of greenhouse gas emissions. The cooperation includes initiatives like lowering emissions, increasing the use of recycled content, and setting Science Based targets. [132]

Furthermore, Company 7 understands that achieving its sustainability goals requires a collective effort. Therefore, they maintain rigorous engagement with their suppliers, assessing their emission levels and encouraging them to adopt more environmentally friendly practices. Through this collaborative approach, Company 7 strives to reduce the environmental impact across their supply chain. [132]

4.7.3 Comparison of Results: Company 6 and Company 7

Company 6 and Company 7, both leaders in their respective sectors, have demonstrated strong commitments to environmental sustainability. Their approach to LCA and SBTs illustrate the strategic foresight needed to achieve sustainability goals.

In terms of LCA use, Company 6 has built a substantial database covering several thousand product LCAs, which forms the backbone of its approach to managing Scope 3 emissions. This in-depth analysis allows them to track and manage carbon emissions across their extensive product portfolio accurately. Company 7, on the other hand, uses comprehensive LCA studies to gain insights into the environmental impact of their products and uses

these insights to continuously refine their packaging solutions. Notably, their studies have shown that their cartons using bio-based polymers have a lower carbon footprint compared to alternative materials. [131], [132]

Unique initiatives set the two companies apart. Company 6's initiative for climate promise for suppliers seeks to actively involve suppliers in their sustainability journey. This proactive engagement, set to involve 300 suppliers by 2023, contributes significantly to their goal of net-zero emissions [C6.1]. Company 7, meanwhile, has implemented a program involving the majority of their base material suppliers, aiming to accelerate their sustainability transformations, which is essential in achieving their net-zero emissions goal [132].

In terms of SBTs, both companies are adherents of the SBTi and have ambitious targets. Company 6 is committed to achieving significant reductions in emissions from company-owned sources by 2025, while Company 7 aims for net-zero GHG emissions in operations by 2030. Both companies have shown a proactive approach in working towards these targets, as seen in their supplier engagement initiatives and commitment to reporting in line with GRI Standards and the CDP. [131], [132]

Challenges faced by both companies primarily revolve around Scope 3 emissions, as this involves a wide range of variables outside their immediate control. Company 6 has combated this by working closely with suppliers and focusing on data-driven analysis. Similarly, Company 7 has emphasized engagement with suppliers, aiming to inspire industry-wide transformation.

While both Company 6 and Company 7 have their unique approaches to sustainability, they share the common thread of a proactive and comprehensive strategy. They underscore the value of the SBTi framework and the LCA in developing effective climate action. As models for sustainability, they demonstrate how a thorough, data-driven approach can yield significant strides towards reaching ambitious sustainability targets. These companies show that rigorous sustainability strategies can enhance reputation and brand image, offering an additional incentive for businesses to follow suit.

4.7.4 Implications for Company 1 and the Electrical Equipment and Machinery Sector

Although operating in a different sector, Company 1 can draw valuable insights from the sustainability strategies employed by Company 6 and Company 7. Their innovative methods for emissions reduction, commitment to

carbon neutrality, and supplier engagement strategies offer transferable practices that Company 1 could incorporate into its sustainability agenda.

Company 6's implementation of a comprehensive LCA database provides an effective model for tracking and calculating emissions. By adopting a similar LCA strategy, Company 1 could establish more detailed emissions inventory spanning its entire product life cycle, from raw material sourcing to end-of-life disposal. Such an approach would enhance transparency and help identify high-emission stages for targeted reduction.

Company 7's robust engagement with suppliers exemplifies a proactive approach to managing indirect emissions. Company 1 could draw inspiration from this strategy, setting stringent emissions standards for suppliers and integrating sustainability clauses into contracts. Regular audits and supplier support could further ensure compliance, extending Company 1's sustainability efforts across the supply chain. The net-zero emissions commitments of both Company 6 and Company 7 highlight the value of setting ambitious, time-bound targets [131], [132]. Company 1 could establish its own emission reduction goals, aligning all operations, supply chain management, and innovation initiatives towards this shared objective.

Finally, the role of innovation in the sustainability strategies of Company 6 and Company 7 is worth noting. For Company 1, a similar focus could drive the development of energy-efficient designs and processes. Investment in R&D might lead to greener solutions for its products, reduced environmental impact from manufacturing, and business models prioritizing sustainability.

In conclusion, while each industry poses its unique sustainability challenges and contexts, Company 6's and Company 7's experiences indicate that a comprehensive, proactive, and innovative approach can drive significant progress towards sustainability goals, providing key lessons for Company 1 and the broader electrical equipment and machinery sector.

4.8 Customer Expectations for Company 1's SBTs and Scope 3 Emission Reduction

As the importance of global climate change continues to grow, an increasing number of businesses are committing to SBTs. Achieving these targets requires deep collaboration and a unified vision of sustainability among partnering organizations. Therefore, it is crucial to understand the expectations and needs of Company 1's customers, particularly in relation to Scope 3 emissions reduction.

Considering the initial challenges of securing participation from a wider range of companies in the electrical equipment and machinery sector, this research was expanded to include a focus on customer expectations towards Company 1's SBTs and Scope 3 Emission Reduction efforts. This approach is based on the analysis of sustainability data and ESG reports available online and supplemented by an interview with Company 1's Sustainability team. [C1.3]

As part of this research, we examined customer expectations towards Company 1, identified potential areas for enhancement in Company 1's current practices, and highlighted the importance of benchmarking and competitor analysis. The aim is to ensure Company 1's strategies align with the evolving sustainability goals of its customers, thereby fostering a shared journey towards a more sustainable future.

4.8.1 Customer SBT Commitments Related to Scope 3 Emissions

To understand more about customer expectations and possible emission reduction preferences from the customers, the following sections detail the specific commitments of Company 1's selected customers regarding Scope 3 emissions. These emissions arise from the value chain of a company's activities, particularly the use of sold products and purchased goods and services. These Scope 3 emissions targets reflect each company's unique sustainability strategy and present significant implications for Company 1's own emissions reduction efforts.

The selected customers of Company 1 have set forth robust commitments to significantly reduce their environmental impacts. These customers aim to reduce their Scope 3 emissions, with targets ranging from 20% to 50% by 2030, using various baselines from previous years. These reductions highlight the customers' emphasis on addressing the environmental impacts across different areas, including construction materials, operational phase energy consumption, and the carbon footprint of their supply chain. Their strategies span a wide spectrum [C1.3]:

- **Engaging Suppliers:** Customers are engaging with their suppliers to minimize the carbon footprints of materials. This engagement ensures that the products and services sourced have minimal environmental impacts.
- **Improving Operational Efficiencies:** They focus on improving energy efficiency during both the construction and operational phases of their projects. This involves adopting green building technologies, enhancing property energy efficiency, and embracing low-carbon materials.

- **Adopting a Holistic Approach on Scope 3 Emission Reduction:** The customers are adopting comprehensive approaches to sustainability, targeting emissions not only from the use of sold products and downstream leased assets but also from areas like business travel.
- **Fostering Supplier Partnerships:** The partnerships with suppliers aim to collectively reduce emissions across the entire value chain, emphasizing a holistic approach to sustainability.

These commitments reflect the broader industry trend of recognizing and addressing the environmental impacts of operations, products, and supply chains. For Company 1, understanding these strategies and aligning with them can enhance collaborations and contribute to shared sustainability objectives. [C1.3]

4.8.2 Customer Expectations for Company 1's Contribution to SBT Goals

As businesses worldwide commit to SBTi, customer expectations for Company 1's contribution to these environmental objectives are becoming increasingly defined. Predominantly, these expectations center around energy efficiency, transparency in emissions reporting, and collaborative endeavors to lower emissions.

Customers anticipate Company 1 to provide innovative, energy-efficient solutions for its products. These energy-efficient solutions could contribute significantly to the reduction of emissions associated with the use of sold products. By focusing on such solutions, Company 1 could help their customers in their pursuit of sustainability goals, particularly those associated with the usage phase of sold products. [C1.3]

Furthermore, customers expect Company 1 to engage and collaborate with suppliers to minimize the carbon footprint of materials used in Company 1's products. Such a step would play a pivotal role in aiding customers in meeting their targets related to purchased goods and services. The reduction of Scope 3 emissions from purchased goods and services is a complex task that requires significant collaboration and effort along the supply chain. By working closely with suppliers, Company 1 can have a considerable impact on these emissions, helping customers meet their SBT goals. [C1.3]

Cooperation is another key expectation of Company 1's customers. Customers seek Company 1's active participation in joint initiatives and projects aimed at reducing emissions throughout the value chain. This includes initiatives focused on improving energy efficiency, reducing materials' carbon

footprint, and advancing other sustainable practices. This active participation and collaboration ensure alignment with their SBT commitments and fosters a cooperative approach to achieving sustainability goals.

Finally, transparency in reporting Company 1's emissions data is also a major expectation. Accurate and clear emissions reporting allows customers to assess their progress correctly in achieving Scope 3 targets. It aids customers in tracking their performance, understanding the impact of Company 1's products and services on their emissions, and devising strategies to further reduce these emissions. [C1.3]

4.8.3 Opportunities and Challenges for Companies in Achieving Customer Expectations

In an increasingly sustainability-focused world, companies encounter both opportunities and challenges, with their commitment to align with their customers' Scope 3 emissions reduction targets serving as a critical turning point influencing their strategic direction. The expectation from customers for energy-efficient solutions has opened significant opportunities for companies to innovate. By enhancing the energy efficiency of their products, companies can not only assist their customers in achieving their SBTs but also strengthen their competitive standing in the market.

Simultaneously, the urgency to minimize the carbon footprint of materials used in companies' products presents an opportunity to engage suppliers in driving emission reductions across the supply chain. This challenging approach could foster stronger partnerships, promote transparency, and facilitate shared learning opportunities.

The growing commitment of businesses to the SBTi underscores the importance of proactive participation by companies in joint initiatives to reduce emissions. These collaborations can deepen companies' relationships with customers and other stakeholders, highlighting their commitment to environmental sustainability and strengthening their brand reputation. However, companies also face challenges in fulfilling customer expectations, as identified in the literature review. The complexity of Scope 3 emissions, which encompass a wide range of indirect emission sources, poses a formidable challenge. These emissions are typically harder to monitor and reduce than direct emissions, necessitating significant effort to meet customer expectations. [C1.2]

Further complexity arises from the demand for transparency in emissions reporting. To meet the growing customer requirement for clear, accurate, and comprehensive emissions data, companies need to establish robust da-

ta collection and analysis systems. This resource-intensive process may face difficulties in quantifying certain types of emissions, but achieving this transparency is vital for building trust and credibility among stakeholders.

Furthermore, companies are confronted with the challenge of balancing their environmental commitments with their economic objectives. Investing in energy-efficient technologies and comprehensive emissions reduction initiatives often requires substantial financial resources, potentially impacting companies' short-term profitability. This balance between economic performance and environmental sustainability is crucial for companies' future direction.

4.9 Analysis of Company 1's Suppliers SBT Commitment and Questionnaire Survey Results

In the context of a rapidly changing business environment, aligning organizational goals with SBTs has emerged as an indispensable aspect of responsible corporate functioning. For Company 1, this alignment extends beyond internal operations to encompass a wide network of suppliers. The research conducted detailed Company 1's efforts to engage with its suppliers, evaluating their understanding, commitment, and specific goals related to the SBTi, and subsequently outlining a comprehensive strategy for future collaboration.

Company 1's suppliers play a critical role in contributing to its SBT goals. They are responsible for a significant portion of the company's overall carbon footprint. As such, supplier engagement is not merely a peripheral activity but a central driver in Company 1's journey towards sustainability. This engagement emphasizes collaboration, capacity building, and shared commitment towards carbon neutrality.

4.9.1 Survey Methodology

To gain insights into the alignment and commitment of Company 1's suppliers with SBTs, a mixed-methods approach survey was conducted among the suppliers. The survey was distributed via email and designed to engage suppliers in reflective discourse on their current sustainability practices, alignment with SBTi, and future strategies.

A purposive sampling technique was used to target Company 1's suppliers, as they constitute a vital part of Company 1's supply chain. This non-probability sampling method involves selecting individuals or groups with specific knowledge or expertise related to the subject. Unlike random sampling, this technique focuses on choosing subjects purposefully. In the con-

text of Company 1's suppliers, this approach allowed the researcher to target the suppliers specifically because they represent a significant share of Company 1's supply chain, thus making them the most relevant subjects for the survey.

4.9.2 Response Analysis

From the suppliers who participated in the survey, a significant number of responses were received, indicating a marked interest in the subject. Upon careful analysis and verification of these responses, it became evident that while many suppliers claimed an allegiance to SBTi, only a select few had verified commitments, as confirmed by the SBT website under the "Companies Taking Action" section [15]. These findings highlight a noticeable gap in suppliers' understanding of SBT commitments and their implications.

This disparity between reported and verified commitments indicates a lack of understanding. The survey also sheds light on an urgent need for transparent communication and education about SBTi's role within the supply chain. The low verification rate signals concern about the commitment levels and a potential discrepancy between stated and actual commitment to sustainability practices. Furthermore, it became evident that although suppliers may have their sustainability and emission reduction targets, these are often not validated under SBT standards. The existence of these individual targets shows a willingness to engage in sustainable practices but lacks the discipline and alignment with global climate objectives that SBTi provides. This gap underscores the need for further examination of supplier understanding and ability to meet SBT-validated targets.

Considering the insights from the survey, companies can adopt several strategies to align their supply chains with their sustainability objectives:

- **Increasing Supplier Evaluations and Audits:** This involves companies creating an evaluative framework that emphasizes compliance with SBTi, ensuring that supplier commitments are not just stated but are also implemented.
- **Strengthening Supplier Requirements:** Implementing stricter requirements in contractual agreements, including SBTi compliance, can guarantee supplier alignment with companies' sustainability objectives.
- **Educational Programs and Raising Awareness:** Developing workshops and informative materials focusing on the importance of SBTi can foster a shared understanding and help suppliers align with global climate goals.

- **Integrating SBT Commitments into Procurement Policies:** Prioritizing SBT alignment in supplier selection and incentivizing commitments can further ensure that suppliers understand and align with companies' sustainability goals.
- **Participation in Industry Initiatives:** Engaging in industry initiatives to promote sustainability and SBTi can help create a broader impact and foster a culture that prioritizes these important aspects among suppliers.

The effective implementation of these strategies requires a well-structured approach that leverages companies' industry influence to foster a sustainable and resilient supply chain. By understanding the importance of SBTi and addressing the challenges evident in the survey, companies are well-positioned to drive meaningful change not only within their immediate network but across the wider industry landscape. This commitment to SBTi, coupled with strategies that enhance understanding and verification among suppliers, will be key to achieving companies' sustainability vision.

The above findings present an empirical view of the current state of supplier engagement and alignment with SBTi within Company 1's supply chain. The analysis highlights the complexities and challenges in accurately assessing supplier commitment to sustainability and reveals the gaps in understanding and validation that exist. Further research might explore ways to bridge these gaps and develop more robust mechanisms to align suppliers with global sustainability goals.

5 Results

This chapter explores the outcomes of the research, concentrating on six critical areas identified during the empirical analysis phase. The study revealed complexities and details associated with both the enhancement of companies Scope 3 emission calculation methodology and the effort to minimize the carbon footprint of delivered steel through an emphasis on recycled content and pioneering emission reduction techniques. The research also discusses the addition of green steel production initiatives into the supply chain, refining companies' supplier engagement strategies, understanding the importance of SBT commitments, capitalizing on customer engagement around SBTs, and grasping the impact of CBAM on supply chain operations.

It is important to emphasize that although these findings are derived from the data gathered during the research process, the interpretations and recommended areas for enhancement are based on my analytical conclusions. These recommendations offer perspectives on potential ways through which companies in the electrical equipment and machinery sector could refine their processes and practices in the specified areas. These findings not only reveal the opportunities and challenges embedded within companies' commitment to environmental responsibility but also underscore specific areas for improvement and development. The ensuing discussions will highlight each of these multifaceted aspects, articulating the empirical insights that could guide further enhancements in companies' sustainability approach and alignment with broader industry trends.

5.1 Enhancing Companies Scope 3 Emission Calculation Methodology

The importance of refining Scope 3 emission calculation methodologies has been underscored in our prior discussions on methodological approaches and emission calculations, as highlighted in Chapters 4.6.1 and 4.6.2. While a variety of strategies are being adopted across different companies, it is evident that there is a growing need for enhanced precision, standardization, and alignment with global best practices. For companies, this enhancement is not just about refining calculations but is a reflection of a broader commitment to sustainable business practices. Therefore, enhancing Scope 3 emission calculation methodology was selected as a crucial step forward in the companies' sustainability journey.

Scope 3 emissions are a critical part of assessing the overall environmental impact. In response to the increasing importance of sustainability in today's

global landscape, companies have undertaken the challenge of creating a more nuanced and precise calculation methodology for these emissions. This endeavor required an alignment with international standards, and a customization that considered the companies' specific operational context.

5.1.1 Existing Challenges and Limitations

Scope 3 emissions are vital in assessing a business's environmental impact because they capture all indirect emissions in the value chain. Within companies' operational framework, the methodology for computing these emissions presents several challenges.

Typically, companies rely on manual data entry and transfer for Scope 3 emissions calculations, which involves individual analysis of the data. While this approach is functional, it has notable limitations. The need for manual data entry not only increases the time and resources required but is also susceptible to human error and inefficiencies, especially as companies' operations expand. Limitations become evident with larger datasets, leading to slow performance or potential system failures. The process of integrating data from various sources lacks fluidity, posing the risk of outdated or inconsistent data. Furthermore, when multiple stakeholders access and edit the files, discrepancies can arise, leading to inconsistencies in reported emissions. Despite the available analytical tools, the system falls short in advanced statistical analyses and predictive modeling, limiting companies' insights into emissions data and future trends.

The inconsistency in data across suppliers presents a significant challenge. Without uniform standards, data can vary in format and quality, thereby obstructing accurate calculations. The absence of standardized reporting procedures across different sectors of the supply chain further complicates the measurement process. Ambiguous boundaries defining responsibility for emissions introduce another layer of complexity. Without clear definitions, identifying where responsibility begins and ends can result in potential overlaps or gaps in calculations. Moreover, varied methodologies across different sectors prevent a unified and holistic view of the environmental impact. These multifaceted challenges highlight the pressing need for comprehensive improvement in companies' existing methodologies.

5.1.2 Enhancement Ideology

In response to existing challenges, companies should embark on a mission to create a more nuanced and precise calculation methodology for Scope 3 emissions. The enhancement will be driven by the need for precision, transparency, and alignment with global standards. By closely collaborating with

suppliers, companies can aim to standardize data collection procedures, laying down a consistent foundation that curtails discrepancies. To address the unique intricacies of their supply chains, companies can plan to develop a comprehensive strategy. This will encompass in-depth analysis, modeling, and alignment with the GHG Protocol as well as pertinent ISO standards.

An important development idea for companies' ongoing sustainability strategy is the creation of an innovative system that would maintain a database of different parts and product materials, collected from suppliers. This system is designed to archive data for emissions calculations based on the mass of materials used, which will lead to more precise emissions quantification. Typically, this data is transferred manually for emissions calculations. The integration of considerations regarding recycled materials will also be crucial, reflecting a more accurate view of the environmental impact. Additionally, companies can establish clear definitions to demarcate boundaries for emission responsibility, ensuring alignment with the latest industry guidelines.

In the event of implementing companies enhanced methodology, the process is expected to be both rigorous and collaborative. This would entail launching extensive training sessions for suppliers to foster collaboration and mutual understanding. Additionally, independent audits would be utilized to validate the new system, ensuring that it meets all requisite standards with unbiased precision.

A baseline comparison will also be crucial to verify the improved accuracy of the new system. This step-by-step process will ensure that the new method is theoretically robust, practically applicable, and verifiable, aligning with both scientific precision and real-world applicability.

5.1.3 Ongoing Development and Future Directions

Companies’ commitment to sustainability extends beyond the immediate implementation of their enhanced Scope 3 emission calculation methodology. As global standards evolve, companies are dedicated to aligning their methodology with these changes, ensuring that it remains relevant and accurate.

Engaging suppliers in regular dialogue and feedback, companies are strengthening collaboration across the supply chain. This active engagement enhances both compliance and innovation in data collection and reporting. Investing in advanced technology and tools is another key strategy, allowing companies to refine its calculations and reporting further. Among these strategies is the inclusion of the innovative materials database system

mentioned earlier. By leveraging automation and data analytics, companies can deepen insights and improve efficiency.

One future development idea under consideration involves the transition from manual data gathering for emission calculations to a more streamlined approach. The innovative system for companies that was envisioned in previous chapter can fetch emission values directly from its database, based on the consumption of various product materials. This data would then be used to calculate emissions for each product directly by the same system, eliminating the need for additional manual calculations. Such a transformation would necessitate software and system development to integrate a calculation engine with the emissions database system, offering a leaner and simpler emission calculation methodology.

Furthermore, the companies emphasize the importance of education and training, both internally and with suppliers. Continual education ensures that the enhanced methodology is understood and correctly applied, fostering a culture of sustainability across the entire supply chain.

The enhancement of companies Scope 3 emission calculation methodology is a multifaceted task that encompasses addressing current issues and planning future implementations. By recognizing and addressing the present challenges, companies are laying the groundwork for future innovations that will align with global standards and embrace specific needs. The envisioned future work in ideology enhancement and implementation represents a strategic and forward-thinking approach, reflecting companies' commitment to sustainability and environmental stewardship. It also sets a precedent for the industry, marking a significant step towards a more responsible and sustainable global environment.

By viewing Scope 3 emissions as part of a broader sustainability strategy, coupled with advanced methodology and industry standards, companies have established a notable benchmark. This approach showcases how a focused, straightforward, and proactive strategy can successfully address one of the most urgent environmental issues of our time.

5.2 Improving Supplier Engagement and SBT Commitments

As highlighted in Chapters 4.6.3, 4.6.4, and 4.9, improving supplier engagement and their dedication to SBTs is vital. Supplier assessment and collaboration are key in managing Scope 3 emissions and identifying areas for reduction. Taking a closer look at how suppliers commit to SBTs, along with other green efforts, shows the need for regular communication with them.

When companies strengthen their work with suppliers and focus on SBTs, it shows a true commitment to green practices. Therefore, for companies to advance in their sustainability journey, a thorough review and improvement of supplier engagement and their dedication to SBTs are essential.

Companies' suppliers play a significant role in contributing to SBT goals, as they are responsible for a considerable portion of the companies' overall carbon footprint. Supplier engagement is not just a minor activity for companies but a crucial driver for achieving their SBT objectives. This forms the cornerstone of companies' holistic and inclusive approach towards sustainability, emphasizing collaboration, capacity building, and shared commitment towards carbon neutrality. It is critical to note that supplier engagement involves not only encouraging the adoption of SBTs but also helping suppliers overcome obstacles that might impede progress.

Companies can encourage their suppliers to set specific GHG reduction targets and report on their progress towards meeting these goals. This practice fosters transparency and accountability, strengthening the mutual commitment towards SBTs. By providing support, companies can help suppliers overcome challenges and facilitate continuous improvement in their sustainability performance. This process can include regular supplier assessments, reviewing progress reports, and offering guidance on implementing effective emission reduction measures.

5.2.1 Enhancing Engagement with Companies Suppliers on SBT Goals

In the pursuit of constantly improving sustainability measures, an enriched approach for supplier engagement is being proposed. This advanced approach is based on the principles of collaborative synergy. When companies engage even more intensively with their suppliers, the aim is to craft and execute innovative strategies focused on the significant reduction of GHG emissions and the elevation of sustainable practices. The envisioned enhancement would lead to a greater number of joint R&D projects, fostering a culture of knowledge exchange encompassing best practices and learnings that are an offshoot of companies' sustainability expeditions.

Additionally, by firmly embedding supplier-specific SBT goals within the procurement plans, the companies' aim is to attain consistent alignment across their vast supply chain with their sustainability direction. Such an enhanced approach can be a significant driver in creating impactful changes. By adopting and achieving their own SBTs, suppliers not only assist companies in reaching their sustainability targets but also contribute to broader environmental goals. They would also strengthen their own sus-

tainability reputation, establishing a unique position for themselves in a business environment that is increasingly leaning towards sustainability.

5.2.2 Increasing the Number of Suppliers Committed to SBTs

To expand the scope of its sustainability efforts and ensure wider adoption of suppliers' SBTs, companies can adopt several strategies listed as follows.

Integrating SBT Commitments into Procurement Policies
By integrating SBT commitments into their procurement policies, companies can prioritize suppliers with SBT commitments, making SBT alignment a key factor in supplier selection and evaluation. This move effectively incentivizes potential and existing suppliers to adopt SBTs, as this could determine their business relationship with companies.

Raising Awareness and Providing Support
Companies can engage with their existing suppliers to raise awareness about the importance of setting and achieving SBTs. This involves sharing information about the benefits of committing to SBTs and offering guidance on how to establish and work towards SBT goals. By doing so, companies can facilitate a better understanding of the economic, environmental, and social benefits of adopting SBTs, thereby stimulating increased commitment.

Incentivizing SBT Commitments
Beyond integrating SBT commitments into procurement policies, companies can create incentives for suppliers to commit to SBTs, such as preferential treatment in contract negotiations, opportunities for business expansion, or recognition through supplier sustainability awards. This approach can spark change within the supplier network and promote an organizational culture that prioritizes sustainability.

Participating in Industry Initiatives
Companies can join, or support industry initiatives aimed at promoting SBT commitments and climate action among suppliers. By collaborating with other organizations and leveraging collective influence, companies can help create a broader impact on supplier sustainability performance.

Having discussed various potential strategies of companies, it is beneficial to compare their approaches with each other. This comparison reveals striking differences and similarities. For instance, some companies have been proactive in providing consistent outreach and training programs for subcontractors, particularly those with significant purchasing volumes. Their approach of combining training on CO_2 reduction with interpreting the nu-

ances between different emission scopes provides a comprehensive foundation for suppliers. This method of engagement provides a template that other companies could consider, ensuring a more holistic and effective approach towards suppliers.

In verifying their suppliers' commitment to the SBTi, some companies employ both internal and external sustainability audits. This extensive verification process ensures that suppliers not only align with the companies' sustainability standards but also effectively implement the measures they commit to. While other companies already employ supplier assessments, the thoroughness some companies apply offers an insightful benchmark for further improvement. Such in-depth audits could amplify other companies' ability to hold suppliers accountable and drive meaningful progress.

Furthermore, some companies' ambition to aim for 30% of their direct suppliers to adopt SBTs by 2025 showcases their aggressive strategy to push for broader SBT adoption. This goal setting offers a path for other companies to potentially set similar or even more ambitious targets, thereby underscoring the importance of setting clear and aggressive benchmarks for supplier commitment.

5.2.3 Challenges and Solutions in Engaging Suppliers Towards SBTs

Engaging suppliers towards SBTs can pose some challenges for companies. These may include resistance from suppliers due to a lack of understanding or resources to implement SBTs, balancing the demand for competitive pricing with sustainability goals, and ensuring compliance and consistent progress reporting from a diverse set of suppliers.

Companies approach to these challenges emphasizes continuous engagement, education, and support. This ensures an enhanced understanding and implementation of SBTs. Tailored strategies, developed in collaboration with suppliers, can provide a customized approach aligning with each supplier's unique capacity and business model.

For instance, to tackle the challenge of resistance from suppliers, companies could consider organizing workshops and training sessions, showcasing the long-term benefits of SBTs, both in terms of sustainability and profitability. Another solution might be the use of third-party verification and standardized reporting practices to help ensuring accountability and transparency, building a resilient framework for sustainable growth.

5.3 Minimizing the Carbon Footprint of Delivered Steel by Emphasizing Recycled Content and Innovative Emission Reduction Approaches

Reflecting on the findings of Chapters 2.9 and 4.6.5, the importance of the recycled content level in steel production stands out, especially given its significant environmental impact. As industries worldwide move toward environmental responsibility, managing the carbon footprint of delivered steel by focusing on recycled content is vital. Therefore, understanding the diverse strategies and methods to amplify the integration of recycled content becomes essential for charting a path towards a more sustainable future.

The carbon footprint of delivered steel is a great concern in the steel industry, especially in Asian countries. This issue extends beyond national borders, affecting the global economy and environmental sustainability. Additionally, the recycled content levels in steel have a significant impact on companies in the electrical equipment and machinery sector. The emphasis on recycled content within this industry not only aligns with sustainability goals but also has direct implications for key global players, illustrating the interconnectedness of steel production, recycling, and various industrial sectors.

As discussed in the literature review Chapter 2.9, recycled content plays a crucial role in delivered steel from Asian countries with varying levels of utilization. This discrepancy highlights the diverse challenges that these countries face in managing their economic growth, waste management infrastructure, and policy support for recycling activities.

There is substantial potential for increasing the recycled steel content in the steel production of Asian countries. However, realizing this potential is fraught with complexity. Balancing sustainability with other essential aspects of business, such as safety, cost, quality control, and technological advancement, underlines the intricate nature of implementing recycled steel initiatives. For example, the proposed reduction in lead content, an initiative introduced by the EU to minimize its poisonous impact, could compromise the steel's toughness, posing potential safety risks. This challenge emphasizes the delicacy of aligning sustainability efforts with other critical business facets.

5.3.1 Collaborative Efforts and Challenges

Engaging in global collaborative efforts, such as participating in workshops and initiatives sponsored by organizations like the WWF, is crucial for encouraging steel suppliers across Asia to embrace green steel initiatives. The planned participation of companies in these decarbonization-focused workshops underscores the significance of collective action. This collaboration fosters industry-wide decarbonization and emphasizes the need for a multifaceted approach to decarbonization, as merely increasing the recycled content in steel is insufficient for adequately reducing emissions.

A significant obstacle to progress in these areas is the difficulty of obtaining accurate and reliable data for modelling recycled content levels and green steel goals. Addressing this challenge is essential for appropriately assessing and tracking advancements across various countries in Asia. Additionally, the development and implementation of supportive policies, incentives, and public-private partnerships are needed to make the use of recycled steel more economically attractive for producers.

5.3.2 The Future of Recycled Content in Steel and Alternative Strategies

When recycled steel content cannot be increased further, other multifaceted approaches to decarbonization are essential. This includes improving energy efficiency in production processes, adopting low-carbon technologies like hydrogen-based steel production and carbon capture, and implementing material efficiency and circular economy practices. Designing products for longer life, modular design for easy repair and upgrading, and using alternative materials can significantly reduce steel demand and emissions across various industries. The future of recycled content in steel production looks promising but is contingent on multiple factors. These include technological advancements, regulatory support, market dynamics, public perception, and global collaboration. Considering these factors, potential alternative strategies are as follows.

Advanced Material Science
Investments in Advanced Material Science offer the potential for developing new steel alloys with reduced energy requirements, thereby opening new avenues for sustainable production. This includes research into novel materials that can replace traditional high-impact inputs. Emerging innovations in material science may pave the way for creating steel with higher strength-to-weight ratios and corrosion resistance, utilizing recycled content without compromising quality.

Circular Economy Approaches

Emphasizing waste reduction, efficient resource utilization, and product design, the Circular Economy Approach heralds a paradigm shift towards sustainability. This approach requires a system-level perspective, integrating the efforts of producers, consumers, regulators, and researchers to create a more resilient and environmentally responsible industrial ecosystem. The implementation of circular economy principles means not only recycling materials but also rethinking product design and extending product lifespan. This concept also explores opportunities for reusing steel components, remanufacturing, and reconditioning.

Investment in Renewable Energy

International collaboration on technological development and standardization, along with investment in renewable energy, provides a path towards reducing fossil fuel dependence. This transition represents a significant opportunity but also requires careful planning, investment, and alignment with broader energy and industrial policies. Decentralized energy systems, wind and solar integration, and emerging technologies like hydrogen production can provide cleaner alternatives for powering steel manufacturing processes.

Behavioral and Structural Changes in the Industry

Fostering a culture of innovation, collaboration, and transparent reporting will be instrumental in shaping a sustainable future for the steel industry. This includes not only technological innovation but also changes in organizational practices, industry norms, and regulatory frameworks. Encouraging industry-wide collaboration and setting common standards can build a more cohesive approach to sustainability. Moreover, educating consumers and policymakers about the benefits and possibilities of recycled steel, aligning incentives, and building public-private partnerships can further accelerate the transition towards sustainability. The introduction of market incentives such as carbon pricing or tax breaks for sustainable practices, coupled with stringent yet supportive regulatory landscapes, can significantly impact the rate of innovation and adoption of new technologies.

Integration of Alternative Strategies

The future of the steel industry lies in the integration of these alternative strategies, ensuring that they work in synergy to achieve greater sustainability. The harmonization of policies, technologies, and market mechanisms will require collaboration across different sectors, industry, government, and international organizations. This integrated approach recognizes that no single strategy will be sufficient in isolation. Rather, a concerted and multidimensional effort is needed to reduce the carbon footprint of steel production, meeting the demands of a growing population.

The road to a sustainable steel industry in Asia is complex, requiring a blend of technological innovation, policy support, public awareness, and global collaboration. Investing in research, development, and commercialization of low-carbon technologies, coupled with a robust focus on energy management, can pave the way for a future where steel production aligns with environmental goals.

Increasing recycled steel content and minimizing the environmental impact of steel production in Asian countries involves a multifaceted and integrated approach. Balancing sustainability with business needs, improving data gathering, fostering global collaboration, and leveraging insights from leading companies in the field are vital components in reducing the carbon footprint of delivered steel. This comprehensive approach not only promotes sustainability in the steel sector but serves as a model for a broader transformation towards a greener future in various business functions and industries, contributing positively to worldwide environmental targets. The real-world insights shared by companies serve as a valuable guide for other businesses navigating the complexities of sustainability in their operations.

5.4 Incorporating Green Steel Production Initiatives into the Supply Chain

Based on the insights from Chapters 2.10 and 4.6.5, there is a clear emphasis on the importance of green steel initiatives. The previous chapter highlighted the critical intersection of environmental responsibility with steel production, illustrating both the promise and the challenges ahead. As industries worldwide transition towards more environmentally conscious operations, the integration of green steel initiatives within the supply chain becomes increasingly critical. Exploring this area reveals valuable strategies, opportunities, and the detailed aspects essential for smoothly incorporating green steel practices into the broader structure of the supply chain.

Green steel production initiatives such as Responsible Steel Initiative, World Steel Association's Sustainability Charter, and SteelZero are aimed at reducing the carbon footprint and promoting sustainable practices in the steel industry. These initiatives can have significant implications for companies in the electrical equipment and machinery sector, as they rely on steel as a key material in their products and operations.

As shown, each of these green steel production initiatives has unique features and objectives, but they all share a common goal of promoting sustainable practices in the steel industry. The Responsible Steel Initiative focuses on certification and stakeholder engagement, the World Steel Asso-

ciation's Sustainability Charter emphasizes voluntary commitment and reporting, SteelZero targets demand-side transformation and collaboration.

For companies in the electrical equipment and machinery sector, understanding and engaging with these initiatives can provide insights into sustainable steel sourcing and supply chain management. By working with suppliers who are aligned with these initiatives, companies can ensure the procurement of more sustainable steel, reduce their Scope 3 emissions, and enhance their overall sustainability performance. Additionally, companies can leverage best practices and collaboration opportunities offered by these initiatives to drive innovation and reduce the carbon footprint of their products and operations.

A critical aspect of sustainability in companies' supply chains is working closely with suppliers to increase the recycled content in metals, ensuring that these sustainability efforts do not compromise the safety or quality of the products. As mentioned in Chapter 2.9, the EU's proposed reduction in lead content in steel manufacturing may compromise the toughness of steel and pose potential safety risks [104]. Such complexities underline the need for comprehensive solutions that consider various aspects of business-like safety, sustainability, and cost.

5.4.1 Companies Supply Chain and Green Steel Production Initiatives

Typically, companies rely on a global supply chain for materials and components while operating the electrical equipment and machinery sector. With the advent of green steel production initiatives that advocate for carbon-neutral practices, responsible sourcing, and utilization of recycled materials, several changes can affect companies' supply chains. Adherence to these standards may lead to an increase in costs for companies.

Moreover, compliance with new sustainability requirements may pose challenges to suppliers, leading to potential disruptions in supply chain continuity. An analysis of companies' suppliers indicates varying readiness levels to adapt to new standards, and some might face difficulties in obtaining necessary certifications or implementing carbon reduction measures.

To counter these challenges, companies could adopt strategies such as targeting an increase in low-carbon materials within the upcoming years, initiating dialogues with suppliers to encourage reductions in carbon emissions, developing alternative sourcing strategies, and investing in local suppliers with green credentials to ensure uninterrupted operations. Additionally, embedding sustainability considerations across business functions is crucial to ensure long-term alignment with green steel initiatives.

5.4.2 Competitive Landscape and Collaboration Opportunities

The incorporation of green steel production initiatives could reshape the competitive dynamics within the electrical equipment and machinery sector. Green steel initiatives might create differentiating factors among companies in the sector, and early adopters might gain advantages in regulatory compliance, customer perception, and access to green financing.

Companies should undertake a comprehensive competitive analysis to understand how these initiatives impact the competitive landscape. Understanding trends among competitors will enable companies to strategically position themselves, possibly through investing in R&D to create products with a reduced carbon footprint. Emphasizing their commitment to sustainability can attract environmentally conscious customers. Additionally, building partnerships with other industry players and participating in collective sustainability efforts, like SteelZero, could strengthen companies' reputations and foster innovation.

Additionally, there are various opportunities for collaboration within the industry to drive collective sustainability goals. Participation in forums, conferences, and joint research initiatives could facilitate the sharing of best practices, technological advancements, and insights into sustainable steel production. Collaboration with universities, research institutions, and industry bodies could also enhance companies' position in steering the sector toward sustainable practices.

5.4.3 Strategies for Addressing the Impacts of Green Steel Production Initiatives

Companies can adopt several strategies to address the impacts of green steel production initiatives on their supply chain operations as follows.

Enhancing Supply Chain Sustainability
Companies can work with their suppliers to reduce their carbon emissions by implementing energy efficiency measures, investing in renewable energy, adopting circular economy practices, and promoting a more sustainable and diversified supply chain. Reliable data gathering and tracking of green steel goals can be significant challenges, but overcoming these obstacles will enable accurate assessment and progress monitoring.

Collaborating with Suppliers and Investing in Innovation
Companies can engage with their suppliers to foster collaboration, encourage the adoption of sustainable practices, and invest in R&D to create innovative, low-carbon solutions. Joint initiatives could include sharing best

practices, providing technical support, or investing in low-carbon technologies, aligned with the broader trends and best practices in the industry.

Monitoring Regulatory Developments, Market Trends, and Communicating Sustainability Achievements
It is essential for companies to monitor regulatory developments and market trends related to green steel production initiatives, as well as proactively communicate their sustainability performance and commitment to addressing climate change. This could help companies maintain a strong reputation among their stakeholders and ensure that their supply chain remains resilient and competitive in the face of new climate policies.

5.4.4 Potential Benefits and Opportunities from Green Steel Production Initiatives for Companies

In addition to addressing the challenges posed by green steel production initiatives, companies can also benefit from opportunities arising from the implementation of these initiatives as follows.

Market Differentiation and Access to Green Financing
By embracing sustainable practices, investing in low-carbon solutions, and understanding the intricacies of sustainability, including balancing efforts with other crucial aspects of business, companies can differentiate themselves from competitors and attract environmentally conscious customers and partners. This can lead to a competitive advantage and access to green financing options.

Regulatory Compliance and Risk Management
By staying ahead of regulatory changes and adapting their supply chain to the new requirements set forth by green steel production initiatives, companies can effectively manage compliance risks and avoid potential penalties. This proactive approach can also help companies maintain a strong reputation among their stakeholders, demonstrating their readiness to face the challenges posed by these initiatives and other climate policies.

5.5 The Impact of CBAM on Companies Supply Chain Operations

Based on Chapters 2.11 and 4.6.6, the introduction of CBAM and its implications on supplier cooperation have become increasingly pronounced, showing the important role that CBAM will have in shaping both strategy and operations. As we delve into different companies' supply chains, understanding the relationship between CBAM and supply chain strategies is key.

Therefore, a deeper look into CBAM's impacts offers a comprehensive perspective on its influence on global trade, operational costs, and overarching sustainability goals.

The introduction of the CBAM marks a significant change in global trade dynamics, aiming to address concerns like carbon leakage while adjusting allowances such as free allocations. Through semi-structured interviews within the electrical equipment and machinery sector, insights were gathered about the possible impacts of CBAM on enterprises. The data from these interviews substantiated our research, providing a deeper understanding of the real-world implications of this new policy.

The supply chain operations are complex, especially for companies that are involved in the machinery manufacturing industry. The addition of CBAM to the regulatory environment presents both challenges and opportunities. The interactions between carbon emissions regulation, global trade patterns, economic welfare, legal considerations, and business strategies create a multifaceted landscape that requires expertise and foresight to navigate.

CBAM's enforcement might increase companies' expenses as suppliers transfer the carbon cost to the company. This is particularly relevant for goods and precursors like steel, aluminum, and electricity, which are vital in the production of different companies' products. CBAM may also disrupt companies' supply chains if suppliers fail to comply with the new regulations, especially those supplying the targeted goods and precursors. Additionally, the goal of CBAM to address carbon leakage means that suppliers outside the EU might adjust their pricing or production methods. Free allocations, while acting as a temporary relief to some industries, might alter the cost dynamics for companies, especially if suppliers benefit from these without passing the savings.

To mitigate these risks, companies might need strategies such as increasing the use of low-carbon materials, working with suppliers to reduce their emissions, and devising contingency plans for operational continuity. During research interviews, concerns were expressed about potential cost increases and supply chain disruptions, underscoring the need for proactive strategies to address CBAM's impacts.

5.5.1 Strategies for Addressing the Impacts of CBAM

Companies have the potential to implement various strategies to navigate the CBAM's effects. By collaborating with suppliers, they can curtail carbon emissions through steps like energy conservation, venturing into renewable energy, and adopting circular economy methodologies. With the phased

introduction of CBAM and the gradual reduction of free allocations, companies' medium to long-term planning should factor in the potential changing costs and benefits.

In the rapidly changing global environment marked by increasing eco-awareness and regulatory demands, diversifying the supply chain is critical for innovative companies. This goes beyond just seeking alternative suppliers, by establishing strong alliances with partners committed to carbon neutrality. This not only signifies an adaptation in companies' business strategy but also marks a significant stride towards promoting a green global economy, playing a critical role in the collective efforts to mitigate climate change impacts.

Moreover, investing in R&D is crucial. For the companies in the electrical equipment and machinery sector, spearheading innovations in eco-friendly technologies could offer significant long-term benefits, economically and environmentally. This proactive investment strategy positions companies as a frontrunner in the green transition, aligning with market trends and showcasing visionary leadership.

Simultaneously, complying with regulatory frameworks and maintaining continuous oversight are essential aspects of maintaining a responsible business operation. This approach ensures compliance with regulations, preserves a competitive stance in a green-conscious market, and demonstrates companies' commitment to fostering a sustainable future through transparency and adherence to environmental standards.

5.5.2 Potential Benefits and Opportunities from CBAM

The response to CBAM is not merely about adaptation, but it presents a chance for differentiation. By aligning their operations with the goals of CBAM, companies could carve out a unique market position. This goes beyond mere compliance, extending to a full embrace of a new business environment shaped by climate considerations.
Access to green financing might emerge as a major incentive for companies, as investors and financial institutions increasingly consider environmental impact as a core criterion for investment. By positioning themselves as frontrunners in sustainability, companies might gain competitive advantages and preferential access to green financing options, including lending rates, green bonds, or other instruments designed to support environmentally friendly projects.

Furthermore, companies could enhance their corporate reputation, resonating with a growing global consumer base increasingly concerned about en-

vironmental sustainability. This alignment with societal values could translate into tangible commercial advantages.

5.5.3 Challenges and Potential Risks

Despite these opportunities, CBAM's introduction represents a complex challenge. There will likely be increased costs associated with compliance, especially in the short term. These are not merely financial costs but also encompass time, effort, and organizational focus.

The legal and regulatory landscape is also a potential minefield. CBAM is a new and evolving set of regulations, and its interaction with existing international trade agreements and national laws will likely be intricate and sometimes unpredictable. The potential for disputes under the WTO framework, among other legal considerations, adds a layer of complexity.

Additionally, the global trade implications are vast. The mechanism's influence on international trade dynamics could significantly affect import costs and global sourcing strategies. The ripple effects through international markets could be profound and wide-ranging, affecting everything from raw material prices to end-consumer demand.

In addition to addressing the challenges posed by CBAM, companies can distinguish themselves from competitors by embracing sustainable practices and investing in low-carbon solutions. By working with suppliers to reduce emissions and implement energy-efficient measures, companies can attract environmentally conscious customers and partners. This approach can lead to competitive advantages and access to green financing options.

Proactively staying ahead of regulatory changes and adapting to new CBAM requirements will enable companies to manage compliance risks and avoid penalties effectively. This approach will also support companies in maintaining a robust reputation, showcasing their readiness to face the challenges posed by CBAM and other climate policies.

5.6 Utilizing Customer Engagement on SBT and Expectations

Building upon insights from Chapter 4.8, it is clear that understanding and addressing the expectations of companies' customers holds significant importance. With the changing dynamics of the business environment and an intensifying focus on sustainability, the role of customer engagement in the realm of SBTs and Scope 3 emissions reduction is ever more crucial. This section has been crafted to further the insights from Chapter 4.8, offering a

closer look at practical strategies and resulting outcomes stemming from customer expectations.

The strategic incorporation of customer engagement in determining and implementing SBTs has become an essential aspect of companies' sustainability efforts. One result is to explore companies' engagement with their major customers in the context of SBTs and Scope 3 emissions reduction, detailing the challenges, opportunities, and implications for the companies' broader sustainability strategy.

5.6.1 Customer Engagement Approach

Companies' customer engagement approach can be multifaceted and nuanced, reflecting the complexity of the SBTs framework and the diversity of their customer base. Collaborative dialogues form the cornerstone of this approach, with regular interactions, meetings, dialogues, and conferences with customers. Regular interactions allow companies to align their products with customer sustainability goals.

Through these dialogues, companies can capture insights into the specific needs and expectations of their customers, aligning their products and services more closely with these sustainability goals. While the companies' dialogue approach has been highly beneficial, our research identified a unique finding: smaller customers, in contrast to key global clients, expressed a desire for more region-specific engagement strategies, something not heavily discussed in existing literature.

In addition to dialogue, companies have embraced joint initiatives that involve collaboration on projects focused on sustainability, innovation, and efficiency. These collaborative efforts have emphasized companies' commitment to shared goals, allowing them to work directly with customers to develop tailored solutions and create a shared understanding of best practices.

Transparency in reporting is also a central component of companies' engagement strategy. By providing clear, accurate, and timely emissions data, companies have not only built trust among their customers but also facilitated joint strategies for emissions reduction, enabling more precise tracking of progress towards shared SBTs.

5.6.2 Customer Expectations and Alignment

Companies' customer engagement has revealed several key expectations that shape their approach to SBTs. First and foremost, there is a strong em-

phasis on energy efficiency that aligns with companies' goal to innovate energy-efficient solutions for their products. Companies' customers have set different targets for Scope 3 emissions reduction, necessitating engagement with suppliers to minimize the carbon footprint. Customers are also looking to companies to provide innovative solutions that not only meet their needs but also contribute to their emissions reduction targets.

This expectation extends to companies' interactions with their suppliers, particularly concerning the reduction of Scope 3 emissions. Customers expect companies to engage and collaborate with suppliers to minimize the carbon footprint of materials used in their products. Such an approach is challenging and requires significant collaboration and effort along the supply chain, but it can have a substantial impact on emissions.

Another key expectation revolves around companies' active participation in industry-wide initiatives and their leadership in areas emphasizing sustainability. This participation and leadership signal companies' commitment to broader environmental goals and align with the strategic directions of their customers.

5.6.3 Opportunities and Challenges

Customer engagement could lead to significant opportunities for companies. Engagement opens avenues for technological advancements and innovation. By understanding customer needs in detail, companies can develop energy-efficient solutions that not only meet current demands but also anticipate future trends. The growing expectation for energy-efficient solutions has also spurred innovation, allowing companies to develop tailored solutions. Collaborative efforts on sustainability initiatives foster deeper relationships, building trust that translates into competitive advantages.

The complexity of Scope 3 emissions presents a significant challenge. These indirect emissions are typically more difficult to monitor and reduce than direct emissions, requiring significant resources and expertise. While Scope 3 emissions remain a challenge industry-wide, some customers seem more concerned about tangible, on-ground sustainability efforts rather than the intricate details of the Scope 3 metrics.

One of the primary complexities regarding Scope 3 emissions is the reliance on a multitude of suppliers and partners, each with their own emissions and environmental practices. Addressing these emissions requires a strategic alignment with partners to ensure that they also comply with companies' sustainability objectives. Companies are actively working on this alignment

through thorough supplier assessments, training, and collaboration, fostering an ecosystem that supports their emissions reduction goals.

Furthermore, companies must balance their environmental commitments with their economic objectives. Investing in energy-efficient technologies and comprehensive emissions reduction initiatives can require substantial financial resources, potentially impacting the companies' short-term profitability. To overcome this challenge, companies could adopt a strategic investment approach that aligns sustainability efforts with long-term financial planning, demonstrating a commitment to maintaining a balance between economic performance and environmental sustainability. This balance between economic performance and environmental sustainability is a complex and ongoing challenge for companies' leadership. By combining internal efforts, collaborations with suppliers, and strategic planning, companies can build a model that integrates sustainability into their core business processes without compromising their financial objectives.

6 Discussion

The completion of this research signifies a crucial milestone in unraveling the complex dynamics of SBTs across multiple industry sectors. The information gathered from this study clearly shows the varied routes companies are taking in their efforts to be more sustainable. It also offers a thoughtful analysis of the progress made and the difficulties faced in the industry's effort to balance business growth with caring for the environment.

6.1 Reliability and Transparency

In the methods section, the utilization of both primary and secondary data collection techniques was detailed, establishing a solid foundation for the study. Through interviews with key individuals from selected companies and surveys targeting suppliers, a comprehensive picture of business strategies, obstacles, and partnerships was developed in the context of pursuing SBTs.

Maintaining reliability was a cornerstone of this research. Over several months, interviews and surveys were systematically conducted, incorporating inputs from representatives of well-known companies. Table 1 presents a meticulous overview of the interviews conducted, illustrating the transparent and methodical approach adopted during the data collection phase.

Further enhancing the reliability and transparency of this research was the thorough approach undertaken during the literature review phase. A variety of sources, including peer-reviewed journals, industry reports, and authoritative books were consulted, creating a comprehensive backdrop for the study. This methodology not only secured the reliability of the information presented but also significantly contributed to forming a well-rounded discussion rooted in existing scholarship. This extensive review operated as a credible platform for analyzing both primary and secondary data, fostering a comprehensive exploration of corporate strategies regarding SBTs. Future research endeavors might benefit from continually expanding the scope of literature reviewed to capture emerging trends and insights, thus fostering a dynamic and current discourse on the subject matter.

Secondary data were also gathered through the analysis of SBTi databases and ESG reports, integrating seamlessly with the primary data and providing timely insights into the sustainability plans and goals of the companies investigated. This dual approach not only enhanced the reliability of the data but also amplified the transparency of the research process.

However, a closer examination of the data collection process reveals areas potentially prone to mistakes. The qualitative nature of the primary data might have incorporated some elements of personal viewpoints, an aspect that future studies should strive to mitigate by integrating more quantitative or mixed-method analyses to ensure a balanced perspective and minimize subjective influences.

6.2 Challenges Encountered

This research, like many others, faced a series of distinct challenges. Initially, a significant issue was the limited participation in the questionnaire interviews from the electrical equipment and machinery sector, as highlighted in Chapter 3: Research Methods. This limitation could have narrowed the scope and depth of the insights gathered. To address this, the research was later expanded to incorporate questionnaires in the container and consumer products sectors, broadening the perspective and enriching the data pool, which facilitated a more comprehensive analysis.

The varied answers received reflected the different strategies used by companies in different sectors. Although this provided a lot of information, it made it difficult to combine these views into a clear story. Furthermore, the number of responses from the selected companies and the level of detail obtained from other sources sometimes made it hard to fully understand the specific strategies and how they were put into action by different corporations.

6.3 Evaluation of Research Outcomes

Evaluating the results of this study through the lens of the theories and models mentioned in the literature review, the research aligns well with established concepts while also bringing new ideas to the table. The collected and analyzed data create a solid base for checking how closely real-world actions follow the expected paths described in theories, setting the stage for deeper investigations in upcoming studies.

This project has significantly addressed the knowledge gaps identified during the initial literature review, providing an intricate analysis of current trends and strategies instrumental in achieving SBTs. As the study progressed, new gaps emerged, prompting a supplementary literature review to explore burgeoning concepts and developments, notably focusing on areas such as the CBAM and green steel initiatives. These reviews were then seamlessly integrated into the relevant sections, thus offering a rounded and up-to-date perspective on the fast-evolving landscape of corporate sustainability.

The research brought a fresh perspective to the complex methodologies surrounding Scope 3 emission calculations. Innovations and improvements in this field are vital in accurately determining the carbon footprint of various activities within the supply chain. Diving deeper into this aspect can significantly assist corporations in achieving their SBT commitments, aligning with government initiatives to curb global warming.

Significant insights were gained regarding improving supplier engagement to enhance the effectiveness of SBT commitments. The strategies employed by corporations, such as leveraging technology for real-time tracking and fostering collaborative relationships with suppliers, were particularly noteworthy. Further studies in this domain can potentially reveal more nuanced strategies to bolster supplier engagement and commitment towards SBTs.

A notable part of the study was focused on minimizing the carbon footprint of delivered steel by emphasizing recycled content and innovative emission reduction approaches. The incorporation of green steel production initiatives into the supply chain marked a vital step towards achieving a sustainable future. Future research can focus on the practical challenges and opportunities in this field, providing a roadmap for industries to follow.

The research also analyzed the impact of CBAM on supply chain operations. The findings highlighted that corporations are in various stages of adapting to this change, with some showcasing innovative approaches to comply with CBAM's guidelines. Further studies can evaluate the long-term impacts and the strategies to optimize supply chain operations in the wake of CBAM.

Customer engagement emerged as a pivotal element in the successful implementation of SBTs. The study revealed that corporations are increasingly utilizing customer feedback and expectations to shape their sustainability strategies. This not only fosters a sense of responsibility among consumers but also aligns corporate goals with customer expectations, thereby creating a win-win scenario.

Comparing this with earlier studies mentioned in the literature review shows both similarities and differences in the findings. Importantly, the research has revealed fresh details about company strategies, showing new patterns and trends that were not recognized before. This detailed analysis acts as a springboard for more conversations and research, helping to build a full understanding of how SBTs are implemented across different sectors.
Thinking about what this study adds to existing literature, the research has opened new viewpoints and discoveries in the area. The deep dive into the topic not only brings more depth to what is already known but might also

encourage more detailed discussions and research in the future, adding a lot to the information available in this important area.

When we evaluate the outcomes of this study, it is important to use a critical eye that values the insights gained but also notes where the research might have strayed off from the original goals set in the introduction chapter. The wider focus, which included a larger range of industries, although not planned at the start, made the research richer by giving a wide-angle view of SBT practices across different areas. However, this broader focus might have lessened the depth of information about the sector first aimed at, affecting the results of the study.

The study managed to work through the complicated world of corporate sustainability successfully. A sharper initial analysis, perhaps guided by the gaps noted in the literature review, might have made selecting participant companies easier, reducing the early issues with getting responses. Also, while the research contains a lot of qualitative data, adding more quantitative analysis might have given a more detailed view and increased the analytical depth, aligning better with the theories and models discussed in the literature review. This thoughtful reflection points out possible paths for future research, creating opportunities for more complete and balanced studies in corporate sustainability.

6.4 Future Directions

Encapsulating several months of meticulous research, this report outlines the prevailing corporate sustainability efforts, amalgamating insights, strategies, and challenges faced by companies as they navigate their journey towards achieving Science Based Targets. The research, through its detailed exploration, has fostered a rich repository of knowledge that could potentially guide companies in aligning with industry best practices.

A sector-specific focus could enrich future research. Diving deep into specific sectors such as the manufacturing or technology sector could unearth nuanced insights, allowing for a detailed understanding of the strategies, challenges, and collaborations characteristic to these industries. Moreover, expanding the geographical scope of the study can provide a global perspective on the efforts taken by corporations worldwide, thereby offering a more holistic view.

7 Conclusion

The master's thesis embarked on a detailed exploration of the important role of SBTs in contemporary corporate sustainability initiatives. Detailed analysis revealed that companies in the electrical equipment and machinery sector have been making significant strides in strategizing and collaborating to achieve their SBTs, thus playing a vital role in shaping the corporate sustainability landscape.

Throughout the data collection process, which took place from February to May 2023, a meticulous approach was adopted aiming to incorporate a diverse array of perspectives and experiences. This initiative has fostered a deeper understanding of the dynamic trends in corporate sustainability, expanding upon existing knowledge and introducing fresh viewpoints into the conversation.

By utilizing both primary and secondary data collection methods, significant discussions from existing literature were analyzed to form a well-rounded view of the current sustainability strategies and objectives pursued by various companies. This approach not only blended seamlessly with the firsthand data but also strengthened the overall narrative, providing a solid foundation for discussing and evaluating new paradigms in corporate sustainability.

The analysis unveiled a complex yet innovative network of strategies that corporations have employed to achieve their SBTs. This research managed to build upon existing theories, offering a nuanced evaluation of corporate strategies while potentially reshaping existing narratives in the industry.

Focusing on companies in the electrical equipment and machinery sector, this research served as an opportunity to recalibrate its sustainability goals, promoting an environment where business growth harmonizes with sustainability efforts. The insights gained from this case study can guide other corporations to streamline their strategies more effectively, fostering a future where business operations resonate universally with sustainability principles.

This research highlighted several areas within the SBTs sector that require further scholarly attention. The continuously evolving dynamics of SBTs beckon additional scholarly exploration, potentially focusing on the development of sector-specific frameworks that encapsulate the distinctive challenges and strategies found in each sector. Additionally, future studies might explore more quantitative analyses to provide a comprehensive view of the effectiveness of various strategies adopted by companies in their pur-

suit of achieving SBTs, potentially giving rise to new theoretical frameworks.

Furthermore, anticipated studies promise to unravel the complex dynamics of supplier relationships, focusing specifically on integrating sustainability strategies within supply chain networks, since companies can only be as sustainable as their supply chains. This pathway encourages a more unified and collaborative approach towards achieving SBTs, contributing to a more sustainable corporate environment.

In summary, this thesis serves as a cornerstone of knowledge, fostering informed discussions in the corporate sector and significantly contributing to the existing body of scholarly work in corporate sustainability. Drawing upon theoretical frameworks and identified gaps in the literature review, this research sheds new light on corporate sustainability initiatives, leading the way towards a future where sustainability transitions from an aspirational goal to a tangible reality.

By fulfilling the outlined objectives, this research presents a fresh perspective, encouraging further investigations in the corporate sustainability domain and providing a fertile ground for more scholarly exploration. Consequently, it supports the nurturing of a more sustainable and responsible corporate future, adding a substantial layer to the evolving discourse on corporate sustainability strategies.

At this crucial point in corporate sustainability, this research serves as a catalyst, encouraging industries worldwide to adopt informed and innovative strategies, nurturing a future where corporate growth and sustainability are intricately linked and progress hand in hand.

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Appendix A. The Questionnaire to The Selected Companies in Electrical Equipment and Machinery Sector

1. Can your company achieve its short-term (2030) emission reduction goals? Please evaluate this on a scale between 1-5, where 1= we will not achieve, 5 = we will certainly achieve. Can you justify your estimation?
2. How do you track the progress of your emission reductions, for example, through annual targets?
3. What is your company's SBT decision-making process? What kind of sustainability organization do you have within your company?
4. How significant are SBT and climate change prevention to your company's business development compared to other areas of development?
5. What types of investments or competence building has your company undertaken to achieve SBT goals (e.g., technology, consulting, processes, data collection, system development)?
6. How does your company calculate & measure CO_2 emissions for Category 1: Purchased goods and services, such as CO_2 emissions from used materials?
    6.1. How do you monitor these calculated & measured CO_2 emissions?
    6.2. What data does your company use to calculate CO_2 emissions for used materials? Do you use data provided by suppliers or other data (e.g., emission factors or material volume)?
7. How does your company cooperate with steel suppliers to reduce CO_2 emissions?
    7.1. What actions or factors affect emission levels, such as recycling levels? How are these factors taken into account in your calculation model?
    7.2. How is emission data collected from suppliers?
    7.3. How willing are suppliers to provide the data?
8. Have your suppliers committed to SBTi and reducing Scope 3 emissions, and to what extent? How many suppliers have made such commitments?
9. How do you monitor your suppliers' commitment to SBTi and Scope 3 emission reduction?
    9.1. Additional question for Company 4: What actions has Company 4 taken to increase the number of suppliers involved in the SBT initiative?

9.2. Does this mean that suppliers are guided and assisted by Company 4 to commit to SBT according to its requirements, or something else?

10. Do you measure your suppliers' sustainability performance by audits or scorecards etc.?
11. How does the sustainability performance affect supplier selection or purchasing decisions?
12. How does your company calculate & measure CO_2 emissions from the use of sold products?
    12.1. How do you monitor these calculated & measured CO_2 emissions?
    12.2. What data does your company use to calculate CO_2 emissions from the use of sold products?
13. What are the proportions of different emission sources in the Use of Sold Products category, e.g., fuel or electricity consumption?
14. How long does it take to bring a new energy-efficient innovation/product to the market?
15. Are there any identified problems with Scope 3 emission calculations, data collection (from suppliers & materials) and emission reduction? Do you have ongoing projects or ideas to address these problems?
16. How has your company chosen the Scope 3 categories to focus on for emission reduction?
17. What kind of effort has been put into assembling your Scope 3 emission calculation model (investments/budgeting, development, time usage)?
18. How do the measured & calculated Scope 3 emissions affect your company's R&D, business development, decision-making, and product sales, and over what timespan?
19. What is the verification process for your company's emission measurements & calculations, and who performs the verification?
20. To become carbon neutral, companies can, for example, purchase carbon credits to offset the emissions they cannot eliminate. Which emissions does your company offset with carbon offset projects or carbon credits to achieve carbon neutrality?
21. What kind of Environmental Product Declaration (EPD) process does your company have in relation to your products?
22. What EPDs does your company have and how were these assembled?
23. Does your company take into account sustainability certificates for buildings (LEED & BREEAM) when setting sustainable development and emission reduction goals?
24. What are your customers' expectations regarding your company's SBT actions?

25. How much do your customers' opinions and requests regarding emission reduction influence your company’s emission reduction actions?
26. In which Scope have you included emissions from your office buildings (heating, electricity, etc.) and from the use of your vehicle fleet? How were these calculated? (Usually, these are considered Scope 1 emissions, unless they are included in Scope 3's Category 13: Downstream Leased Assets. Could you clarify this in your company's case?)

Appendix B. The Questionnaire to Companies in Containers and Packaging Sector and in Consumer Durables and Personal Products Sector

1. How do you track the progress of SBT emission reductions? For example, do you set annual targets?
2. How significant are SBT and climate change prevention for your company's business development compared to other areas of development?
3. How has your company chosen the Scope 3 categories to focus on for emission reduction?
4. How does your company calculate & measure CO_2 emissions for Category 1: Purchased goods and services, such as CO_2 emissions for used materials?
5. How does your company collaborate with suppliers to reduce CO_2 emissions?
6. Have your suppliers committed to the SBTi and reducing Scope 3 emissions? To what extent? How many of these suppliers exist?
7. Do you evaluate your suppliers' sustainability performance through audits or scorecards, etc.?
8. What other Scope 3 categories are relevant for your company?
9. How does your company calculate & measure CO_2 emissions for these other relevant Scope 3 categories?
10. What challenges have you identified regarding Scope 3 emission calculations, data collection (from suppliers & materials), and emission reduction? Are there ongoing projects to address these issues?
11. To achieve carbon neutrality, companies can, for example, purchase carbon credits to offset the emissions they cannot eliminate. Which emissions does your company compensate for with carbon offset projects or carbon credits to achieve carbon neutrality?
12. What are your customers' expectations regarding your company's SBT actions?
13. How much do your customers' opinions and requests about emission reduction influence your company’s emission reduction actions?
14. How does your company incorporate sustainability in product development? For example, do you reduce plastic usage in packaging or promote refillable solutions?
15. Which Scope includes the emissions from your company's office buildings (heating, electricity, etc.) and the emissions resulting from the use of your vehicle fleet? How have these been calculated in your company? (Primarily these are Scope 1, unless they are included in Scope 3's Category 13: Downstream Leased Assets. Could you specify this for your own company?)